THURSDAY, FEBRUARY 18, 1897.

OUR MARKETABLE MARINE FISHES.

The Natural History of the Marketable Marine Fishes of the British Islands. By J. T. Cunningham, M.A. Pp. xvi + 368, 2 maps, and numerous cuts. (London: Macmillan and Co., Ltd., 1896.)

THE great Fisheries Exhibition held in London in 1883 gave a marked impulse to the study of our sea-fisheries, and drew the attention both of scientific men and of the more enlightened of the general public to the importance of the subject and to the necessity of endeavouring to "arrive at an accurate estimate of the causes which determine the movements and the variations in abundance of the animals which produce the harvest of the sea." The Marine Biological Association of the United Kingdom, founded shortly afterwards (1884), has done much during the last decade to trace out the life-histories and habits of many of our food fishes; the scientific investigations of the Fishery Board for Scotland, and the researches carried on at Prof. M'Intosh's marine laboratory at St. Andrews, have done still more; and other public bodies and individuals round the coast have assisted in a less degree in collecting the information which has made possible such a book as the one before us.

Mr. Cunningham, who has been employed since 1887 as "naturalist" by the Marine Biological Association at their Plymouth laboratory, produced some years ago a finely illustrated monograph on the common sole; and now, under the direction of the Council of the same body, he has prepared this work on our marketable marine fishes, with the view of bringing before the general reader, in a connected narrative form, the gist of the information contained in the numerous technical memoirs which have appeared from various laboratories during the last few years. It is generally agreed that the fisherman might with advantage know a great deal more than he does about the objects of his search, but there are some of us who think that at the present juncture what is most required is an educated public opinion. It is probably as important for the future of fisheries investigation and improvement, and of just legislation in regard to the fisheries, that the general public should have opportunities of learning and realising the truth in regard to the habits and life-histories of food fishes, and the inter-relations of animals in the sea, as it is that the fisherman himself should be instructed in such matters. In addition to public lectures, by competent authorities, and the establishment of technical fisheries museums, the publication of books such as the present one, and the larger work which we understand Prof. M'Intosh is preparing, should not only prove useful to those who are, *or ought to be*, interested in fishery matters, either for profit or from the legislative point of view, but will serve as a guide in forming opinions on those fishery questions which have now to be discussed and decided by County Councils and Committees for Technical Instruction, by Conservancy and other Boards, in Law Courts and in the House of Commons.

The Marine Biological Association has been aided by large grants from Her Majesty's Treasury on the understanding that special attention should be directed to the investigation of sea-fish and sea-fisheries, and the present volume will naturally be taken as stating the general conclusions arrived at by Mr. Cunningham, the member of the staff especially charged with the fishery investigation, both from his own work and the consideration of the work of other naturalists at various points around the British coast. Under these circumstances it is to be regretted that Mr. Cunningham has not made more use than appears in his book of the statistics and other local investigations of the Lancashire Sea-Fisheries Committee. Most of his statements are taken from observations made at Grimsby and at Plymouth; but the Irish Sea forms an English fishing area second only in importance to the North Sea, and from which examples might well have been quoted. Even in the appendix, dealing specially with the fishing grounds of the British Islands, the Irish Sea is conspicuous by its absence, and no reference is made either to the "inshore" or "offshore" Lancashire trawling-grounds.

Prof. Ray Lankester, as President of the Marine Biological Association, introduces the book with a preface in which he states as his opinion that "nothing short of a physical and biological survey of the North Sea and of the area within the hundred-fathom line on our southern and western coasts can yield the information as to the movements of marine food fishes and the distribution of fishing grounds which is needful if we are to deal intelligently with our sea-fisheries." With that opinion we heartily concur. It is practically what the present writer urged in a presidential address to Section D of the British Association in 1895, when he said . . . "it would be a very wise action, in the interests of the national fisheries, for the Government to fit out an expedition, in charge of two or three zoologists and fisheries experts, to spend a couple of years in exploring more systematically than has yet been done, or can otherwise be done, our British coasts from the Laminarian zone down to the deep mud." I may now add that in such a scheme I should *not* omit the Irish Sea—a natural sea-fisheries district, with breeding grounds and feeding grounds, estuaries, and open sea, great expanses of shallow banks, and coasts where you can go "from the Laminarian zone down to the deep mud," at eighty fathoms, in about twelve miles.

Mr. Cunningham's book is divided into two parts. Part I. is general, and deals with the history of fisheries investigations, the general characters and distribution of marine fishes, their methods of reproduction and their development, their growth, migration, food, and habits; and finally a discussion of practical methods for increasing the supply of fish. Part II. is special, and takes up the history of particular fishes arranged according to their families, from the "Herrings" to the "Suckers." Part I. is interesting reading; Part II. is more the work of reference in which to look up the details of certain species. The interesting story of Sars' discovery in 1864 and 1865, of the floating eggs of the cod, haddock, and mackerel in Norway, and of M'Intosh's important work in Scotland, of the work of the Kiel Commission in Germany, and of the Fishery Board for Scotland, are all given in

the first chapter. But in this historical section the reference to the Sea Fisheries Committees round the coasts of England and Wales is too brief, and their work is practically ignored.

Even though the book is written not for the specialist, but for the general public, we think too obvious and elaborate an attempt has been made to avoid technical terms. Some of the "English" substitutes are no improvement from any one's point of view, and are wanting in precision and sense—for example, we find mammals referred to as "the tribe of beasts," and, curiously enough, after using the term "pectoral fin" at the beginning, the author discards it during the remainder of the book in favour of "breast fin." Then again, when such a technical term as "micropyle" is used, there seems no reason for calling the oviduct "egg-tube"; while to label an unfortunate little blenny "the Gattorugine" is quite as bad as to use its proper scientific name. We should have been glad to have seen the scientific names of the species associated with the English names throughout the book, and especially under the useful outline figures. It is easy to pick up the scientific names, and the sooner those of the public who are concerned with fishery matters do so the better. On p. 40, when defining species, genera, and families, the names of a few well-known genera, such as *Gadus*, and *Clupea*, and their more important species, might have been introduced with advantage.

Although we quite agree with Mr. Cunningham's remark, that at present it must be held that artificial propagation of sea-fish is in its experimental stage, still we think that throughout that discussion on practical methods he does not, in stating the case for hatching, allow sufficiently for the fact that the embryos are protected in the hatchery during a period of their existence when, if at large, they are liable to become the prey of nearly everything in the sea that has a mouth.

There are some misprints in the book, which should have been corrected in proof: *e.g.* on p. 87, *Lota vulgaris* is called the turbot; Prof. M'Intosh's name is misspelled throughout the book, as is also *Hydrallmania*, which should have only one "n."

There are some other points one might take exception to, but we have criticised enough; and most of the blemishes we have alluded to above are of minor importance, and leave the book a really valuable work and a record of much research and long-continued industry on the part of the author. We hope that the book will prove useful in the hands of superintendents of fishery districts and members of our Sea Fisheries Committees. The numerous illustrations are most of them excellent, and the general "get-up" is all that could be desired.

W. A. HERDMAN.

THE LIFE OF JAMES CROLL.

Autobiographical Sketch of James Croll, with Memoir of his Life and Work. By J. C. Irons. Pp. 553. (London: Stanford, 1896.)

THE life of James Croll is very remarkable. That a mason's son, who in youth laboured on the few acres of his father's homestead; who then, having a mind disposed to mechanics, became apprentice to a millwright; who, having served his four years' time, got employment at eight shillings a week, having sometimes to walk thirty or forty miles a day to his work, and to sleep in the barn; who, not becoming inured to such hardships, turned carpenter, and met with some measure of success, till disease in the elbow set in; who then, not having sufficient education for a clerkship, found employment in the tea trade, and was after a time helped by his employer to open a shop for his own profit—in which venture he might have succeeded, even in spite of reading "Edwards on the Will," had not the elbow caused a long and painful illness which ruined the business, and left him with an ossified joint; who then supported himself for a twelvemonth by making electrical instruments wherewith the neighbours might cure themselves of all the ills the flesh was heir to; who, when the demand for the panacea was exhausted, "after due consideration," set up a temperance hotel in a town, Blairgowrie, of 3500 inhabitants, with sixteen inns and public-houses there already, and far from any railway; who, after a year and a half of failure as innkeeper, took to canvassing for various insurance companies, where, as usual, everything went contrariwise with him—that a man, who thus spent nearly the first forty years of his life, should have become so successful a student of metaphysics as to write a work of decided merit on "The Philosophy of Theism," is perhaps not a matter of surprise, seeing that he was a Scotchman. But we may surely indulge our faculty of wonder when we learn that a London publisher was found ready to undertake the whole risk of publishing his work, by an unknown Scotch tradesman or agent, on the terms of half profits, and that the result justified the publisher's enterprise.

But at length, in 1859, these difficulties were overcome, and Croll obtained a situation as janitor at the Andersonian College, Glasgow. The salary was small, but he had ample time to read, and some excellent libraries to consult; and here he may be said to have begun his scientific career. After eight years he was appointed to the Geological Survey of Scotland, where he remained thirteen years. Through ill-health he then retired, expecting to have received a pension calculated on age as well as length of service; but in this he was disappointed. The Treasury refused to pay more than 75*l.* 16*s.* 8*d.* a year. The circumstances of the refusal, as set forth in the correspondence, render the transaction a lasting disgrace to the Treasury. Ten years later he died.

There is here a striking record of difficulties overcome. Yet these, the external difficulties, were the least with which Croll had to struggle. His head, always a bad servant to his mind, became, in 1865, so seriously affected, that never afterwards could he persist for any length of time in mental work, or concentrate his energy on a difficulty until it was overcome. If he attempted to do too much, not only did the pain become unbearable, but he was disabled for several days afterwards. How terribly this affliction influenced his life may be judged from the fact, mentioned in Croll's simple, modest way, that he had to take a by-path in the morning, lest conversing with a friend on the way should unfit him for his office work.

Even from this bare outline it may be judged that the

story of Croll's life, as all too shortly told by himself, and supplemented by Mr. Irons, is one of deep pathos.

Of his character, deeply impressed by the truths of religion, Calvinistic, conscientious to a degree, possessed of the most inflexible power over himself, not hesitating to subject himself to severe and long-continued physical suffering when he thought it his duty, full of generosity in assisting other inquirers after truth, we obtain many glimpses in the volume before us.

Of Croll's scientific work, which bears at once the impress of genius, metaphysically acute, and of imperfect knowledge, the result of unsystematic training in physics, it is more difficult to form a just estimate. It was so controversial, and dealt with matters on which the final judgment of science has not yet been passed. That which he regarded as his most important and most conclusive work in physics—his glacial theory—has been steadily losing ground among geologists and physicists alike, and now it finds difficulty in securing a champion to fight its battles. His work on ocean currents seems more likely to be permanent, for he did much to call attention to the paramount importance of winds in determining oceanic circulation, although he doubtless pushed the argument somewhat too far against Carpenter, the advocate of the temperature theory; yet the very imperfections of his work bear the strongest testimony to the inherent suggestive genius of the man. That one whose knowledge of elementary physical principles was so confused as appears from some of the correspondence, *e.g.* that on pp. 452–458, should have been able to sway contemporary scientific opinion on physical subjects was marvellous, and was due, not only to the extraordinary suggestiveness of his mind, but also to his metaphysical power. By long-continued meditation, the different parts of his theory became in his mind so closely connected together, analogies became so clearly perceived, so unconsciously magnified, that difficulties faded into the background, or, even in his fertile mind, were made to yield new reasons for his conclusions. Yet, through all, the transparent sincerity of the author, and his evident devotion to truth were as clear as his absolute conviction of the necessity of his own conclusions; and thus, as well as by his remarkable power of logical exposition, he imbued the reader with his own confidence, and this the more readily in the case of the glacial theory, because the grandeur and simplicity of the explanation, if it did not afford some presumption of its truth, at least created a prejudice in its favour.

But though Croll's position will doubtless be determined by his work in physics, he would himself have chosen to be judged by his metaphysical writings. If we may judge from the summaries in the work before us, as well as the correspondence from Principal Cairns and others, these works were of striking, though by no means of transcendent, merit.

The book is well printed and got-up. To one who did not know Croll personally, it seems that some of the correspondence might have been omitted with advantage. It is, however, an ungrateful task to criticise what has been a labour of love. The last words of the preface are: "It may be added that the entire proceeds of the sale will be devoted to Dr. Croll's widow."

E. P. C.

ELEMENTARY METEOROLOGY.

Elementary Meteorology for High Schools and Colleges. By Frank Waldo, Ph.D., late Junior Professor in the U.S. Signal Service. Pp. 4 + 373. (New York: Cincinnati, Chicago American Book Co., 1896.)

IN writing an elementary treatise on meteorology, there are two very evident errors which an author may commit. There is the danger of producing a book which is reduced to such simplicity that it becomes wearisome or even needless, because it contains many facts which are either of ordinary experience or have been learnt from other branches of elementary physics. And on the other hand, there is the difficulty, common to all elementary works, of knowing where to stop. To the adept, many facts and deductions, which appear perfectly simple and worthy of attention, are stumbling-blocks to the beginner and become sources of annoyance to the reader. In looking through this book one learns that there are other difficulties which need to be avoided, and though Dr. Waldo has to some extent avoided the big pitfalls by steering clear of childish repetition on the one hand, and injudicious overloading on the other, he has not been so successful in recognising the necessity of accuracy of expression and clearness of explanation. One might, too, take a preliminary objection to the choice of the readers to whom this book is addressed. Dr. Waldo admits in his very first paragraph that the "science is as yet but partially developed, and much that is at present accepted as fact will be modified by future investigations.' The question naturally arises, is it desirable to place before students explanations that are admittedly imperfect, and to devote the time that might be well spent in accurate training to the acquisition of an amount of ill-digested information, that does not in all cases even satisfy those with whom the information has originated? Of course, no blame rests with Dr. Waldo on this score. If those who are responsible for education in America are determined to press some acquaintance with meteorology in its present condition on their pupils, it is clearly the duty of experts to supply the best text-books in their power, so that the least possible injury be effected. Of Dr. Waldo's capacity and intimate acquaintance with the subject of which he treats, there is no question. But he does not always exhibit sufficient care to place his facts in the clearest possible light, so as to be of the greatest possible assistance to the student. As an illustration of this carelessness, we may take the sentence on page 30, beginning, "The heat received by the water surface warms it but slightly." This expression, as it stands, would mean that the surface of the water is but slightly warmed, and the explanation that follows would be incorrect; but what is really meant is that the whole mass of water is but slightly warmed by the sun's rays. Such looseness of expression must be very confusing to a student. Take another instance. It is stated (p. 21), "Our earth, in its revolution round the sun, intercepts less than one-half of a millionth of the whole amount of heat given off by the sun." Why are the words "in its revolution round the sun" introduced? These words obscure the real point at issue, which is, or should be, the comparison of the area of the sphere whose radius is the sun's distance from the earth, with the space the earth occupies in that

sphere. In this sense, the amount of heat intercepted by the earth is so much less than that mentioned as to make the statement misleading. Such blemishes are perhaps slight, and might well be passed over where so much of the work is excellent and well arranged. But a graver charge, and one that will surprise many who take up the book, is the neglect to place Boyle's law in a prominent position. One might go so far as to say that Boyle's law is not even mentioned. It does not occur in the index, and we have not found any reference to it in the text, so that it must be very obscurely expressed; and yet it seems imperative, that to such a fundamental principle great clearness and prominence should be given. We think, too, that the chapter on "atmospheric optics" might well have been omitted. There is nothing peculiar about "atmospheric optics," and if one wanted to know the theory of the rainbow, one would necessarily go to a book on optics, and we should imagine that in the "high schools and colleges" in America, students are taught their optics more thoroughly than is suggested by the sketchy manner in which the subject is here treated.

The most satisfactory chapters of the book are those which describe the winds and the circulation of the atmosphere. The author has closely followed Prof. Ferrel in his general explanation, and his intimate knowledge of the work of this physicist has enabled him to give much valuable information in a succinct and accurate form. Unfortunately, it is precisely in this section of meteorology that some of the views now held are most likely to meet with modification, but the chapters are valuable as presenting in a popular form the present condition of our knowledge. Another special and valuable feature in the book is the collection of results that have been derived from meteorological observations. These results are exhibited both in tabular and graphical form, and always clearly. Whatever may be thought of the value of many of the meteorological observations so persistently and energetically collected, there can be no doubt but through their means many useful facts have been learnt, which it is desirable to make known in the pleasantest manner possible. These results may end only in the knowledge of the climate of the district in which the observations have been made; they may not touch the general principles underlying the science of meteorology understood in its widest sense, but such results have a practical value in many arts and sciences, and it is a praiseworthy task to spread abroad a knowledge of the facts that have been collected, and likewise a grateful task to acknowledge the efforts of those who, like Dr. Waldo, have laboured on behalf of the service of meteorology.

OUR BOOK SHELF.

The Mechanics of Pumping Machinery. By Dr. Julius Weisbach and Prof. Gustav Herrmann. Translated from the second German edition by Karl P. Dahlstrom. Pp. 298. (London: Macmillan and Co., 1897.)

PUMPING operations occupy an important place in engineering works, for they are required for keeping out the water from foundations during construction, for raising water from deep wells, for the disposal of sewage, for the efficient drainage of low-lying lands, and for providing water under pressure for working hydraulic machinery. Accordingly, books explaining the principles of the various types of pumps, and affording information as to their relative efficiency, are valuable to engineers and contractors who are obliged to have recourse to pumping in their works. This book appears to be intended primarily for the instruction of students attending advanced courses on the mechanics of machinery; but the descriptions and clear illustrations of the different forms of pumps, should prove useful to those practically engaged in the raising of water. The first chapter relates to the early forms of water elevators, such as the balanced pole with a bucket hung from one end and counterpoise at the other, known as the *picottah* in Bengal and the *shadouf* in Egypt, flash wheels, scoop wheels, chain pumps, and the archimedean and other water screws; and the efficiencies of the wheels, chain pumps, and screws, are calculated. The three following chapters are devoted to the elementary action, the theory, and the various types of reciprocating pumps, the last subject extending over a hundred pages, or one-third of the book. Reciprocating pumps may be divided into two classes, namely, those having hollow valved pistons, or bucket pumps, and those having solid pistons, or plunger pumps; and they comprise both lift pumps and force pumps, generally combining suction as well, and embrace the most common forms of machines for raising water, and also fire-engine and water-pressure pumps. The fifth chapter describes different forms of rotary pumps, of which the centrifugal pump is the most familiar example, and furnishes calculations with regard to the form, velocity, and efficiency of these types of pumps. In the sixth and final chapter, the principles of the hydraulic ram, ejectors and injectors, spiral pumps, compressed-air pumps, the pulsometer, and syphons are explained with the aid of diagrams. The excellent woodcuts, indeed, 197 in number, dispersed throughout the text, elucidate the descriptions very efficiently. A table of contents at the head of each chapter would have been valuable for guidance, especially when a single chapter occupies one-third of the book, and also a list of the woodcuts, and headings to the principal illustrations; whilst an index of barely more than a page, does not afford adequate opportunities of reference. The translation has been so well performed, that the only reminders of the foreign origin of the book are the metric measures, after which have been added their English equivalents in brackets; but in a book drawn up expressly for English readers, the calculations, as well as the results, should have been converted into English measures, to which the most prominent place should have been assigned, even if it was considered advisable to retain the foreign measures. Pumping machinery has so long formed a speciality of several English manufacturers, that English authors should have rendered it unnecessary to resort to Germany for an exposition of the mechanics of pumping machinery. Germans, however, have been long renowned for the thoroughness of their scientific investigations, and Mr. Dahlstrom, of Lehigh University, has performed a valuable service in putting this book within the reach of American and British engineers and students.

Geography of Africa. By Edward Heawood, M.A. Pp. viii + 262. (London: Macmillan and Co., Ltd., 1896.)

THE publication of this little text-book in Macmillan's Geographical Series will be welcomed by all who are interested in geographical education, or who desire a handy and trustworthy compendium on Africa. Books made up mainly of tables of chief towns, lengths of rivers, and other statistical information, are, we hope and believe, on the decline, and rightly so; for they represent the worst methods of teaching geography. Throughout Mr. Heawood's volume, the principles kept in view are: "In the first place, the rule laid down by Dr. Mill in the 'General Geography' of this series, of proceeding from the general to the particular, has been adhered to; and in the second, a clear understanding of the broad physical features of each region described has been

taken as the necessary basis on which to build up the complete picture of such region as the sphere of human activity." A book constructed on these lines claims attention at the outset; and when, as is the case with the volume before us, the pages give evidence that the author is thoroughly familiar with all the geographical facts pertaining to the region with which he deals, we have the factors which combine to make a work useful as an educational instrument, valuable for reference, and interesting to geographical readers. It is, indeed, not too much to say that no book now in existence contains within such a small compass so much accurate information on the African continent as is given in Mr. Heawood's little volume. The book should be widely used in schools, and for this purpose the summary of the geography of Africa will be found very serviceable. To every one who wishes to possess a concise statement of the physical features, native inhabitants, history, and political development of Africa, the volume can be confidently recommended.

Crags and Craters: Rambles in the Island of Réunion. By W. D. Oliver, M.A. With illustrations and a map. Pp. xiv + 213. (London: Longmans, Green, and Co., 1896.)

IF we were going to Réunion (Bourbon), or had lately come back from it, we should be very glad to fall in with such a book as this. It gives an account of the experiences of an energetic man who spent six months on the island, and went about wherever curiosity led him. There is a good map and several photographs. The only illustration that is not a photograph is wretchedly bad. Our author writes easily and clearly, and has evidently taken pains to collect plenty of detailed information. Here the reader finds geography, history, statistics, scenery, manners and customs of the people—almost everything that can be desired, except natural history. What a pity that Mr. Oliver did not inquire beforehand what the naturalist wants to know about Réunion! Prof. Newton, of Cambridge, would have put him in the way of doing some really good work. A little fresh information about the extinct, or nearly extinct, birds, and the gigantic land-tortoises (if there are any in Réunion) would have greatly enriched the book. In spite of this deficiency, "Crags and Craters" is a valuable contribution. The schoolmaster in search of graphic details about the islands of the Indian Ocean would find much good stuff here.

L. C. M.

Everybody's Guide to Photography. By "Operator." Pp. 162. (London: Saxon and Co.)

AMATEUR photographers are now so very numerous, that this book should find a large number of readers. There are hints on the choice of a photographic outfit, and simple directions on all the operations concerned in the production of good negatives and prints. Instructions are also given how to make enlargements and lantern slides, and on the use of orthochromatic plates, the production of stereoscopic photographs, flash-light photography, and Röntgen ray pictures.

Is Natural Selection the Creator of Species? By Duncan Graham. Pp. xviii + 303. (London: Digby, Long, and Co.)

ACCORDING to the author of this book, evolution by natural selection is a snare and a delusion. Wherefore, he comes forward to sweep away the whole fabric of evolution, and to show "that the condition of the earth and its inhabitants cannot be explained by the action of physical forces, independent of support and direction from an intelligent power." His qualifications for this task may be judged from the avowal that, although he has studied the nature and habits of animals and plants for many years, he has never discovered evidence that conclusively indicated evolution.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Force of a Ton.

THE hydraulic forging presses at the Armstrong works, which I had the privilege of visiting a short time ago, bore the inscriptions—2000 tons—5000 tons; meaning thereby the thrust exerted by the ram; and Dr. Lodge's opinion that the word *weight* should be supplied was rejected by the engineers, as the addition of the word *weight* would imply that the presses *weighed* 2000 or 5000 tons.

It is quietly assumed by Dr. Lodge and his followers that the word *weight* is never used except to denote the force with which a body is attracted by the Earth; as if we should never translate *weight* by *pondus*, *un poids*, *gewicht*, but always by *grave*, *un grave*, *schwere;* as in Galileo's memoir "De motu gravium naturaliter accelerato." To support this assumption the Act of Parliament on *Weights and Measures* is always quoted in a garbled form, with a view of making out that the standard Pound Weight is really not the lump of platinum specified in the Act, but the pressure on the bottom of the box in which it is preserved; probably with the mental reservation of the Mikado, "this is the careless way in which the Act is drafted; we will have it altered next time."

Thus the weight of the standard pound weight should, in Dr. Lodge's language, be given as 32·1912 poundals, when at rest in the box at Westminster, and when it is high-water at London Bridge, but changing suddenly to about 32·2382 poundals when tossed in the air. What the thrust of 5000 tons would become when expressed in poundals, funals, or even tonals, it is fearful to contemplate, as well as the pressure of the water in the press or modern steam pressures in poundals on the square foot.

If this controversial question is studied historically, it will be found that Prof. Perry is quite right in maintaining that the quantity denoted by m in Dynamics, and called the *mass*, is measured in units of *inertia;* the unit of inertia being that quantity of matter which receives unit acceleration from the unit force.

In all continental treatises, and in our own engineering works, the quantity w/g is replaced by the letter m and called the *mass;* this defines the unit mass as that quantity of matter which will receive the unit of acceleration from the gravitation unit of force.

Dr. Lodge changes to the absolute unit of force, and now replaces m by w; so that if the mass of a body is m pounds, it must weigh m lb.; and if moving with velocity v f/s, its kinetic energy is $mv^2/2$ foot-poundals, or $mv^2/2g$ foot-pounds; we have now come back to the engineer's measurement, except that his w has, for some mysterious reason, become m, and a different m to his w/g.

I agree with Mr. C. S. Jackson, to a certain extent in opposition to Prof. Perry, in the opinion that the substitution of m for w/g had better be abandoned; or, as a compromise, the letter m may replace w; because a body whose mass is m or w pounds must weigh m or w lb. in the balance; in ordinary language, its weight is m or w lb.

It is the old mediæval discussion of Nominalism and Realism over again; does the thing alter when we call it by a different name? If a steamer loads 1000 tons of coal, are we no longer to say that this coal weighs 1000 tons; or that 1000 tons weight has been placed on board? Are we to be compelled to say that the coal masses 1000 tons; and that it is 1000 tons mass?

In a redetermination of the volume of the gallon, Mr. H. J. Chaney has found that a cubic inch of distilled water, freed from air, and weighed against brass weights in air, when the temperature is 62° F. and the height of the barometer is 30 inches, is equilibrated by 252·286 grains; and this makes the volume of the gallon 277·463 cubic inches, according to the Act of Parliament (*Phil. Trans.*, 1892). Mr. Chaney calls this 252·286 grains the *mass* of a cubic inch of water; but if the same weighing is carried out in *vacuo*, according to another clause of the Act, an extra 0·266 grain must be added to maintain equilibrium; what are we now to call this 252·552 grains, with respect to a cubic inch of water?

The object of writing m for w/g, or of changing to the absolute unit of force and writing m for w, is merely to get rid of g in the dynamical equations, which concern the problems which alone are capable of direct human measurement.

But this quantity g, so treacherous as Dr. Lodge can testify, should always be kept carefully in sight; any attempt to get rid of it merely causes it to reappear elsewhere in an unexpected place (*expelles furca*, &c.).

The engineer can be left to take care of himself, and does not require to be instructed in an art with which he is perfectly familiar. Considering that he has been compelled to create for himself, without professorial assistance, the whole theory of the internal stresses of rapidly reciprocating machinery as causing vibration, it cannot be correct to say that *acceleration* does not come under his notice.

Certainly he often ignores acceleration in his dynamical equations but that is because he prefers to use the principles of Energy and Momentum; and our elementary text-books would do well to imitate him.

As for Dr. Lodge's hint to the sailor, it is useless and even dangerous for navigation, because it gives the distance of the offing in military land miles; instead of geographical nautical miles, as required, of sixty to the degree.

I am reminded of another delicious hint from a theorist to practical men, taken from a recent text-book of Theoretical Mechanics; the gunner is instructed not to use his favourite whip-on-whip tackle, nor the sailor to set up the backstay in the usual manner, because the theoretical writer finds the Third System of Pulleys practically useless, the strings of his model always becoming twisted.

An engineer can generally be provided with some quiet enjoyment in looking through the pages, and especially the diagrams, of our numerous treatises on Elementary Mechanics, and he will smile at the mental pabulum chopped up small for the benefit of the rising pedagogue.

In this discussion, Prof. T. W. Wright's excellent Mechanics has been lost sight of; it is a complete contrast to our ordinary elementary text-book.

I thoroughly agree with Prof. Wright that the introduction of the *poundal* has done more harm than good, and that it will never be employed, even by Electricians always working in absolute units, who will confine themselves to the Metric System.

The world will never take kindly to saying that the weight of a pound weight is 32·1912 poundals, so long as it is at rest on the table; but that the weight changes immediately to 32·2382 poundals when we toss the weight in the air.

February 6. A. G. GREENHILL.

Symbols of Applied Algebra.

I AM sorry to trouble you with one more letter on this subject. Prof. Lodge objected to the energy formula $wv^2/2g$, and stated that he could only bestow his approbation on a formula which was "independent of every system of units." His example of such a formula involved three quantities of the same kind—namely, three lengths. Being invited to give a formula involving three different quantities—*e.g.* weight, volume, and specific gravity—which should come up to his standard, he gives $W = sV$. Now this formula is certainly independent of every system of units, in the sense that it cannot be used with any known system of units (not even accurately with the C.G.S. units).

To bring out this point, I inquired how this formula is to be used with the poundal. Prof. Lodge observes, in reply, that density is not a mere number, and that specific gravity may be measured in pounds per cubit foot. The former statement is irrelevant; the latter not true if "specific gravity" is taken with the meaning with which it is invariably used.

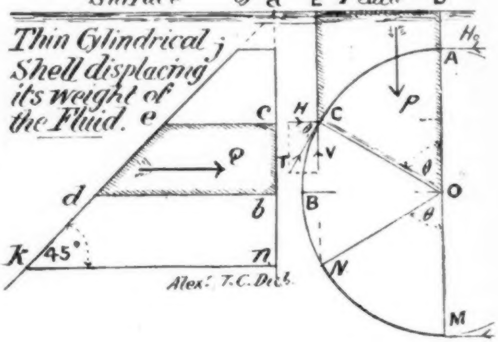
Dr. O'Reilly overlooks, I venture to think, the difference between postponing the consideration of the idea of "mass," and confusing it with "force." Of course, his comment on the formula $P/Q = f/a$ is perfectly correct. C. S. JACKSON.

Equilibrium of a Cylindrical Shell.

AMONG some work on the design of arches which Dr. Thomson, of the Science College, Poona, and myself are preparing for publication in the engineering journals, the following elegant case of the equilibrium of a circular rib occurs. As it admits of a simple physical enunciation and a simple geometrical proof, I think it may interest your readers.

A thin hollow cylinder with a uniform circular shell is submerged in a fluid, and is lying with its axis horizontal. The fluid is excluded from the cylinder by smooth face-plates of the same density as the fluid. The weight of the shell is such that the cylinder displaces its own weight of the fluid. It is evident, then, that the cylinder, as a whole, is in neutral equilibrium, at any depth below the surface. But, further, if the shell be supposed to be perfectly flexible and incompressible, it is still in equilibrium under its own weight and the fluid pressure.

Let the figure represent a ring of the cylinder one foot long, normal to the paper, and let the unit of weight be that of a cubic foot of the fluid. Consider the equilibrium of the arc A C, and it will be seen that V, the vertical component thrust at C, is given by the area of the shaded trapezium E D O C, made up of the superincumbent mass of fluid E D A C, and the weight of the arc A C, which is exactly equal to the fluid mass O A C it displaces.



Again H, the horizontal component thrust at C is given by the area of the shaded trapezium $b\,c\,e\,d$, for H_0 has to balance the whole figure $b\,j$ when the equilibrium of the quadrant A B is considered, and has to balance H together with $c\,j$ when the equilibrium of the arc A C is considered.

Now the two shaded trapeziums have their parallel sides equal each to each, so that their areas are proportional to the distances between their pairs of parallel sides. Hence

$$H : V :: Q : P :: bc : ED :: \cos\theta : \sin\theta,$$

and it follows that the thrust at C is along the tangent to the circle there. In the same way the horizontal and vertical component thrusts at N are given by $n\,d$ and N D, and are again proportional to cosine θ and sine θ. THOS. ALEXANDER.

Engineering School, Trinity College, Dublin, February 9.

Oysters and Copper.

As Prof. Herdman, in his interesting letter on the oyster question, appears to doubt the occurrence of copper in oysters, it may be of interest to mention that, quite recently, I examined some oysters containing this metal in considerable quantity, a single oyster yielding ·04 grammes (about ⅝ grain) of copper.

Some of the oysters were light blue in colour, and others were a dark olive-green, and copper was found in both.

These oysters had been obtained from the Mumbles, near Swansea. W. F. LOWE.

Assay Office, Chester, February 4.

I AM interested to hear of Mr. Lowe's case, where he considers the oysters from near Swansea owe their colour to a very considerable amount of copper. As I stated in the concluding paragraph of my last letter (p. 293), "It is evident that there are several distinct kinds of greenness in oysters." Amongst these I cited Dr. Thorpe's recent demonstration of notable amounts of copper in oysters from Falmouth; so it can scarcely be said that I "appear to doubt the occurrence of copper." Dr. Charles Kohn has kindly re-investigated the matter for me

lately, and has determined the amounts of both copper and iron present in various kinds of oysters by electrolytic methods. He finds the green Marennes oyster contains about 0·4 mgrme. (say ·006 grains) of copper, which agrees pretty closely with the figures given by previous writers. This seems to be the normal amount present in all oysters, white or green, and due to the hæmocyanin of the blood. Dr. Thorpe, however, finds that the green Falmouth oysters have, on the average, each ·023 grains of copper, which falls to the normal amount (·006) on re-laying in another locality, and which is "obviously caused by the mechanical retention of cupriferous particles" (Thorpe, NATURE, p. 107). If Dr. Thorpe means by this that copper mud is entangled in the water and food passages of the oyster, is it not possible that, although the oyster is green, and copper is present, the colour may be due—as in most green oysters—to another cause? This mere entanglement (more or less accidental) of copper-bearing material in the passages of the oyster may also be the explanation of the extraordinarily high figure reported by Mr. Lowe—a figure (·04 grammes) as large, I may remark, as that of the *total ash* in the case of some of my oysters investigated by Dr. Kohn. W. A. HERDMAN.

Liverpool, February 6.

Immunity from Snake-Bite.

IN regard to the immunity from the danger of a second bite which a non-lethal dose of snake venom affords an animal, and also in regard to the question of antitoxin, I would suggest that the comparatively simple case of the sting of bees might be investigated.

The keeper of an apiary once told me that when he first took charge of it, he was laid up for some days by the intense inflammation due to the stings, but that he soon became quite indifferent to the venom. I myself saw him stung several times during a few minutes while he was emptying one hive into another. He had no protection over his hands and face, and, except for the sharp prick of the actual sting, he suffered no ill-effects.

May not the stinging liquid, generally assumed to be formic acid, be of the same nature as snake venom? Might not formic acid have the same effect? R. C. T. EVANS.

SUBJECTIVE COLOUR PHENOMENA.

IN a recent communication to the Royal Society,[1] I described a series of optical experiments which originated in an attempt to account for the colour phenomena exhibited by Mr. C. E. Benham's "Artificial Spectrum Top" (NATURE, vol. li. p. 113). The chief of these experiments are of an exceedingly simple character, and can easily be repeated without the employment of any special apparatus. They demonstrate the formation, under certain conditions, of transient bands of colour along the boundaries between light and dark surfaces.

Let a hole, half an inch square, be cut with a sharp knife in the middle of a sheet of thick brown paper about 15 inches square. The hole is to be covered with gummed white paper taken from the edge of a sheet of postage stamps ("stamp paper"); a small translucent window is thus formed. Across the middle of the window a common pin is to be fixed, like a bar, by means of narrow strips of stamp paper at its two ends. Holding the brown paper in the left-hand between the eyes and a lamp, the observer directs his eyes upon the translucent window; then he conceals it from view by interposing a screen, such as a thin book with a dark cover. After a few seconds, and without moving the eyes in the meantime, he suddenly withdraws the screen; then, if everything is right, and the observer is not unaccustomed to subjective visual experiments, the window will, for a moment after its exposure, appear to be surrounded by a narrow red border, while the pin also will at first appear bright red, not turning black until after the lapse of about one-tenth of a second. The effect is seen best when the lamp is at a certain distance from the brown paper. This distance must be found by trial; in my own case an eight-candle power lamp gives good results when it is about 12 inches behind the paper. The observer's eye should be 10 or 12 inches away from the translucent window.

When once the red border has been detected, it becomes very conspicuous; the difficulty in the first instance being not to see it, but to know that one sees it. The phenomenon is, without doubt, constantly met with, and habitually ignored, in daily life. Since my first observation of it I have many times noticed flashes of red upon the black letters of a book, or upon the edges of the page: bright metallic or polished objects often show a red border when they pass across the field of vision in consequence of a movement of the eyes, and it was an accidental observation of this kind that suggested an experiment like the following:—

Holding the brown paper between his eyes and the lamp, as before, the observer moves it rather quickly either up and down, or round and round in a small circle an inch or two in diameter. The moving window will, owing to persistence, form a straight or circular luminous streak, which will appear to be bordered on both sides with bright red. No person, however unpractised, to whom I have shown this experiment, has failed to see the red border at once. As before, the intensity of the illumination must be properly regulated; so also must the speed of the movement. With strong illumination the red border is very narrow, and is lined with greenish-blue; or the red colour may even be altogether absent.

The above experiments show that when a luminous image (not too bright) is suddenly formed upon the retina, it appears at first to be surrounded by a red border.

The following is a way of showing the same effect by reflected instead of by transmitted light. Two or three black lines, about as thick and as long as an ordinary pin, are drawn upon a small piece of white paper, which is placed upon a table and illuminated by strong lamp-light (not daylight). A black book is interposed between the observer's eyes and the paper, and then very suddenly withdrawn; the lines, when first seen, appear to be red, quickly changing to black. So far the observation is a rather difficult one, but by a very simple device it is possible to obliterate the image of the lines before the redness has had time to disappear; the colour then becomes easily perceptible. A thin black book is held horizontally in the right hand by its left-hand bottom corner, the thumb being uppermost; between the thumb and the book is inserted the right-hand bottom corner of a sheet of white note-paper; the upper right and left corners of the paper and the book respectively are separated, so as to form a triangular open space between them. The book is held an inch or two above the black-lined paper, covering it completely; then the hand is quickly moved from left to right in such a manner that the lines are for a moment exposed to view through the gap between the book and the note-paper, the movement being stopped as soon as the lines are covered by the paper. During the brief glimpse that will be had of the lines while they are beneath the gap, they will, if the illumination is correct, appear to be of a brilliant red hue. It must be ascertained by a preliminary trial that neither the book nor the note-paper casts a shadow upon the black lines when the gap is passing over them.

By a further simple contrivance the red images may be made visible almost continuously for an indefinite time. Upon a disc of white cardboard, from $3\frac{1}{2}$ to 6 inches in diameter, two straight lines are drawn from the centre to the circumference, containing an angle of about 45°; the portion enclosed by the lines is cut out nearly up to the centre, a rim about $\frac{1}{4}$ inch wide being left at the circumference; the remainder of the disc is divided into two equal parts by a straight line from the centre to the circumference, opposite the opening, and one of these parts is painted black with ink. A pin is passed through

[1] "On Subjective Colour Phenomena attending sudden Changes of Illumination." (*Proc. Roy. Soc.*, December 17, 1896.)

the centre of the disc in such a manner that the unprepared face of the disc may rest upon the pin's head (a lady's hat-pin is better for the purpose than a small one); the pin-hole must be sufficiently large to allow the disc to turn freely. Holding this arrangement by the pointed end of the pin (which should be directed vertically upwards) above a design in black lines upon a white ground —any drawing, writing, or printing will do, provided that the lines are not too thick—the observer spins the disc by striking its edge tangentially with his finger in the direction such that the gap follows the black portion, and is followed by the white portion of the disc. If the disc makes five or six turns per second, and the before-mentioned precautions as to illumination and shadows are duly observed, the black lines of the design, seen through the opening in the disc, will appear bright red, and, owing to persistence, the impression will be almost continuous.

When the disc is made to turn in the reverse direction, the lines appear to become (subjectively) blue instead of red. This appearance is partly, if not altogether, illusory. Careful observation shows that the subjective blue tint is not formed upon the lines themselves, which remain black, or rather grey, but upon the white ground just outside them. This and other experiments detailed in the paper indicate that when a dark patch is suddenly formed upon a bright ground, the patch appears for a moment to be surrounded externally by a blue border.

We have then to account for the two facts, that in the formation of these transient coloured fringes, the red originates in a portion of the retina which has not been exposed to the direct action of light, while the blue originates in a portion which is subjected to steady illumination. The effects must, I think, be attributed to sympathetic affection of the red nerve fibres. When the various nerve fibres of the Young-Helmholtz theory are suddenly stimulated by ordinary white or yellow light of moderate intensity, the immediately surrounding red nerve fibres are for a short period excited sympathetically, while the violet and green are not so, or in a much less degree. And, again, when light is suddenly cut off from a patch in a bright field, there occurs an insensitive reaction in the red fibres just outside the darkened patch, in virtue of which they cease for a short time to respond to the luminous stimulus, in sympathy with those inside the patch. The green and violet fibres, by continuing to respond uninterruptedly, give rise to the sensation of a blue border. There is reason to believe that with intense illumination, such as sunlight, these effects are reversed, the sympathetic affection of the red fibres being in such case less than that of the green and violet instead of greater.

The above-mentioned are a few among many curious phenomena which exhibited themselves in the course of my experiments. It appears probable that a careful study of the subjective effects produced by intermittent illumination would lead to valuable results, tending to clear up many doubtful points in the theory of colour vision.

SHELFORD BIDWELL.

A NATIONAL PHYSICAL LABORATORY.

THE Marquis of Salisbury received at the Foreign Office on Tuesday a deputation of representatives of science who asked the Government to establish a national physical laboratory at a cost of £30,000 for buildings, and £5000 a year for maintenance. The *Times* gives the following report of the proceedings.

The deputation consisted of Lord Raleigh, Lord Lister, Sir John Evans, Sir Douglas Galton, Sir Henry Roscoe, Sir Andrew Noble, Prof. W. G. Adams, Prof. W. Chandler Roberts-Austen (Iron and Steel Institute), Prof. W. E. Ayrton, Mr. J. Wolfe Barry (President of the Civil Engineers), Prof. R. B. Clifton, Prof. G. H. Darwin, Mr. Francis Galton, Mr. R. T. Glazebrook, Prof. W. M. Hicks, Dr. J. Hopkinson, Prof. J. V. Jones, Prof. John Perry, Mr. W. H. Preece, Prof. William Ramsay, Prof. A. W. Rücker, Mr. Robert H. Scott (Meteorological Office), Mr. W. N. Shaw, Mr. J. Wilson Swan, Prof. Silvanus Thompson, Prof. W. A. Tilden, Prof. Michael Foster, and Mr. G. Griffith, Secretary of the British Association.

Lord Lister said it fell to his lot to introduce the deputation, as being President of the British Association, with which the idea of a national physical laboratory originated, and also of the Royal Society, which took an equal interest in the matter. Lord Kelvin desired him to say that he was unavoidably absent; he was in full sympathy with their object, and would have been present had it been possible.

Prof. Rücker said the scheme consisted of two parts, which, although closely connected, must be regarded as separate. The first was the proposal for the establishment of a national physical laboratory, and the second was a suggestion of a particular method for giving effect to it. There were certain types of physical investigation which were too laborious and lengthy to be undertaken by individuals or by the staff of an institution the primary duty of which was to teach, but which, on the other hand, were too closely connected with the advancement of knowledge and with research to be undertaken by the staff of a Government department. Of these types, the first was the investigation of slow changes in the properties of matter which persisted through long periods of years. Lord Kelvin had made a beginning in the investigation of these in his laboratory at Glasgow, but it was not too much to say that, although the properties to be investigated might prove to be of great importance both to scientific theory and to industry, very little was known about them at present, or was likely to be known, except by an organised effort such as they now suggested. The second task they wished to undertake was the testing and verification of instruments useful alike to industry and research. Something had been done in this country to meet this want. Standards of various kinds were in charge of the Standards and Electrical Departments of the Board of Trade, but the work which they proposed had a wider scope than that of either of those most useful departments; and the institution which in this country most nearly approached the ideal at which they were aiming was the Kew Observatory. But the permanent endowment of Kew amounted to only £447 per annum, derived from a bequest of the late Thos. Gassiot. Kew was the central observatory of the Meteorological Council, where meteorological instruments of all sorts, photographic lenses, compasses, and many other things were tested and verified; and in the last two years the average number of instruments per annum submitted to investigation had exceeded 21,000. Paris was the seat of the International Bureau of Weights and Measures; and some ten years ago the Physikalisch-Technische Reichsanstalt was founded near Berlin to carry out work of the type which he had just described. Like Kew, it received a private benefaction the gift of the late Dr. Werner Siemens, but this had been largely supplemented by the German Government. At Kew they had to thank the State for the site and the use of an old building. In Germany new buildings had been provided, at the cost of about £200,000, and the annual outlay upon the Reichsanstalt amounted to £15,000. The researches carried out, both in Berlin and in Paris, had in the comparatively short space of ten years produced remarkable results. To give one instance:—Mecurial thermometers were subject to errors which made them very difficult to use for accurate work. Researches on glass carried out in these foreign laboratories resulted in the discovery of a material free from many of the objections which might be urged against ordinary glass, and a prolonged study of the thermometer resulted in increasing the accuracy of mercurial thermometers five-fold. As a consequence of this no high-class mercurial thermometers were now made in this country, and we had to send abroad for them; in fact, at Kew itself our thermometric standards were a series of instruments which had come from Paris, and would have to be sent there to be verified if any accident or careless handling should throw a doubt upon their indications. At the Reichsanstalt there was a large department specially devoted to the investigation of problems useful to industry, and it was understood that instrument-makers, when in doubt as to the best construction of some new and delicate instrument, could obtain help from the experts in the National Laboratory. They were very anxious, therefore, that at Kew, or elsewhere, an institution should be

provided which should do for the United Kingdom that which the Reichsanstalt did for Germany, and that which, so far as its inadequate endowment would allow, Kew had attempted to do for England. The third group of investigations which they wished to undertake was also carried out in the Reichsanstalt—namely, the systematic measurements on the physical properties of various bodies, which would hereafter be data of the greatest importance, both for science and industry. There was no provision whatever for meeting this want in the United Kingdom. They thought the best plan would be to enlarge the Kew Observatory so that the work carried on there might become more nearly equivalent to that undertaken at the Reichsanstalt. The government of the enlarged observatory might be in the hands of a committee appointed by the Royal Society, or a body like the visitors of the Greenwich Observatory, appointed by the principal societies which represented science and industry. They asked for some £30,000 for buildings, and £5000 per annum.

Lord Rayleigh said the enormous sums which were being devoted in Germany in aid of science was a matter which was constantly being brought home to the scientific world; and he could not but feel that unless this country made some effort in the same direction there was very serious danger indeed that we might fall hopelessly in arrear.

Sir Douglas Galton said the assistance they asked for was only a supplement to the policy which the Government adopted a few years ago with the object of promoting technical education.

Mr. J. Wolfe Barry said he felt very strongly that every branch of applied science was greatly in want of such help to its development as would be given by the establishment of a scientific laboratory of research.

Sir Andrew Noble also supported the petition.

Lord Salisbury, in reply, said:—I have listened with very great interest to a subject which certainly is not second in interest to any that I know of, and which has been developed by persons fitter than any others, probably, in this country to expound it. It differs in some respects from deputations that we often have to receive in that it hardly deals with any controverted matter. It is often the duty of a deputation to impress upon a Minister a policy of whose general expediency he is not entirely convinced, and the deputation may take a controversial form. No such development is possible in this case. We are all of us, as we all must be—anybody who has looked into the subject at all—heartily anxious for the attainment of the objects which you advocate so far as they are practicable. But, of course, such a question as you have laid before us to-day depends not for its acceptance upon those wide conceptions of public utility that you have explained; it rather depends upon the narrower issue of finance, for there is surely no Chancellor of the Exchequer in this country who, if he was possessed of a bottomless purse, would not send you out of the room with the concession of everything in this respect that you could desire. The question is as to the furnishing of the means. And there I am afraid I am not able to give you anything like a final or a conclusive answer. I had hoped that the Chancellor of the Exchequer would have been here himself, but he has been forced to take the chair at a very important committee from which it was impossible for him to absent himself, and my courage is not equal to pledging him in his absence. I can only be quite certain that his sympathy is heartily with you, and that he would be very anxious to give such effect to the objects that you have in view as it is in his power to do. I do not think that the exertion which you require from him is quite of the limited kind which has been represented. Prof. Rücker was very moderate in his expressions, but he omitted some very important words in laying his estimate before you which he has printed in the document that he has circulated. He told you that the grant would be £30,000 for buildings, and £5000 a year. But what is said here? "It is thought that at first a grant of £30,000 for buildings and an annual grant of £5000 a year might meet the more urgent necessities of the case." Those are very terrible words to a Chancellor of the Exchequer. They hold out to him indefinite prospects of controversy, in which he himself is not made to play the most agreeable part. I never was a Chancellor of the Exchequer, but I should imagine he would look upon a deputation of this kind, not only from the high philanthropic and patriotic point of view from which he desires to regard it, but also rather as a body of men employed in contriving instruments of torture for himself. Therefore, I must reserve anything I have to say so far as the effect of those figures on his mind may go. But there is one consideration which pressed itself upon me when I read these papers, and still more when I was listening to the interesting speeches that we have heard, and that is, that the kind of security that the Chancellor of the Exchequer would probably want is not assurances of moderation upon your part, which, even if they bind yourselves, will not bind your successors; but some limitation of scope and area in the kind of assistance that you desire from him, which shall prevent, or which shall destroy, that vista of growing and unlimited expense which a Chancellor of the Exchequer is apt to associate with all great national movements of this kind. I have known movements begin with very modest thousands, and end with millions at last. There is a distinction in the objects which you seek, on which I should think it was worth while for you to lay some emphasis. So far as you are inviting the Chancellor of the Exchequer to contribute to an institution for general research, though there can be no question of the value of your objects or of their importance to the public weal, yet you will readily admit that research into the secrets of nature affords a horizon to which there is no end or bound; and he may well be startled at the commencement of a new chapter in the Estimates of whose closing periods he cannot form any conception. But there is one duty of the State which it has to perform in every age, and which it ought to perform now and to perform in increasing ratio as the demands upon it are increased by the widening aspect of science—I mean, if I may use a very grotesque word, which has been very happily used before by the authors of this paper, that the duty of standardising is a duty which the State has always performed—it is nothing but a standard institution. Sir Douglas Galton observed that the stopping of adulteration was really nothing but another form of applying a standard; and so it is in weights and measures and many other respects; and part of what you ask is really standardising, is really to furnish good standards and to furnish a means of ascertaining that the instruments are adapted to those standards and bear a proper relation to them. If the more limited work of standardising was pressed upon the State and the more extensive portion of your work, which involves general and unlimited research, was reserved—for the present, at all events—to such assistance as you might get from private munificence, I think we should have more chance of making a satisfactory beginning. This is, however, only a suggestion. I observed that all the speakers dwelt upon the enormous magnitude of the task that was before us, and I have no doubt they represented accurately not only the facts of the case, but the impression that was made on their own minds. But, still, I think in dwelling on those considerations they hardly displayed the wisdom of the serpent. It is not the magnitude of the task on which it is desirable to lay stress; it is on the importance of those portions of the task which lay immediately to your hand and on their germaneness to the duties which the State has always acknowledged and has hitherto to a great extent undertaken. In the hope that it may be found possible in the greatest possible measure to concede to you the objects which you have in view, but without attempting to pledge the bearer of the purse to the extent to which that purse would be opened, I have only to thank you heartily for your presence here to-day and for the very interesting speeches which I have heard.

Lord Lister thanked the Prime Minister for his kind reception, and the interview then terminated.

NOTES.

THE object of the strong and representative deputation which waited upon Lord Salisbury on Tuesday claims the support of all who are interested in the progress of science and industry. We reprint the *Times* report of what took place at this important meeting, and shall return to the subject next week.

M. GAILLOT has been appointed sub-director of the Paris Observatory, in succession to M. Loewy, who is now Director.

DR. YERSIN, who is now in Bombay, inoculating against the plague, has been made an Officer of the Legion of Honour.

M. SEBERT has been elected a member of the Section de Mécanique of the Paris Academy of Sciences, in succession to the late M. Resal.

A NEW research laboratory is to be erected in the Botanic Garden at Buitenzorg, Java, towards the expense of which the Government of Holland has allowed 6000 dols.

THE first portion of the great museum building of the Brooklyn Institute, being the wing of which the corner-stone was laid in December 1895, will be completed about the middle of March.

THE American scheme for a laboratory for botanical research in the Tropics appears to be assuming a definite shape, Prof. MacDougal having undertaken the duty of organising the Commission which shall visit various localities for the purpose of selecting a site. In a letter in the *Botanical Gazette* for January, Prof. Humphreys, of the Johns Hopkins University, advocates the claims of Jamaica, where there are already two botanic gardens, at Castleton and Gordon-Town, and where the Governor, Sir Henry Blake, is interested in biological science.

WE have received a second paper by Dr. P. Zeeman, "On the influence of magnetism on the nature of the light emitted by a substance." But, with the exception of some theoretical speculations, it does not give much additional information on the experimental discovery announced in the preliminary notice, a translation of which appeared in our columns last week. The paper confirms, however, the main fact, that a sodium flame placed between the poles of a magnet shows a widening of the D lines equal to about one-fortieth of the distance between them. When examined by a Rowland grating, the edges of the widened lines are found to emit circularly polarised light, the direction of rotation being opposite on the two sides.

THE Edouard Mailly prize has just been awarded by the Brussels Academy of Sciences for the first time. It was founded by the late M. Mailly, and amounts to 1000 francs, to be given every fourth year to the person or persons who have most assisted in the extension of astronomical knowledge in Belgium. The first award has been made to the editorial committee of *Ciel et Terre*, viz. MM. C. Lagrange, E. Lagrange, A. Lancaster, L. Niesten, W. Prinz, and P. Stroobant.

THE President of the French Republic visited the Pasteur Institute on February 10, and Dr. Roux was able to show him cultivations of the plague microbe. In the course of his remarks to the President, Dr. Roux observed that the microbe has little power of resistance, and is easily destroyed by antiseptics and by a temperature of 140°. He pointed out, however, that the plague bacillus had the power of retaining its vitality in the soil, and it is on account of this property that epidemics favoured by dense population and insanitary surroundings are perpetuated in Eastern countries.

ACCORDING to the Rome correspondent of the *British Medical Journal*, there appears to be no doubt that Dr. Giuseppe Sanarelli has discovered the bacillus of yellow fever. He will publish an account of his discovery in the next number of a leading Italian hygienic publication, which will be issued in the course of the next few weeks. *La Nazione*, of Florence, has published an article, sent by a correspondent in Montevideo, which states that for some little time Sanarelli hardly believed in his success, but in August his experiments were so clear that he was certain of the discovery of the microbe, and he then occupied himself with the preparation of the serum. His experiments were very extensive; he vaccinated more than 2000 animals, including rabbits, goats, sheep, monkeys, and a few horses. The results of the treatment are definitely reassuring, and in October 1896 he decided to announce confidentially to the President of the Republic of Uruguay the results that have crowned his studies in the origin and cure of yellow fever. If this remedy be truly efficacious, Dr. Sanarelli will obtain the reward of 150,000 scudi (£30,000) offered by the Brazilian Government for the discovery of such a remedy.

SIR H. TRUEMAN WOOD will read a paper upon the "Reproduction of Colour by Photographic Methods," at the Society of Arts on Wednesday next, February 24. The paper will have special reference to M. Chassagne's process of photography in colours, described in NATURE of February 4, and results obtained by this and other processes will be shown.

The Council of the Royal Photographic Society of Great Britain have awarded the Progress medal of the Society to Prof. Lippmann, for his discovery of the process of producing photographs in natural colours by the interference method. The rules by which this medal is given preclude the award of more than one in any year, and since its institution in 1878 ten medals only, including the one mentioned above, have been awarded.

AN interesting paper was read on Thursday last, by Prof. J. C. Bose, at the Indian Section of the Society of Arts, on the promotion of advanced study of physical science in India. The lecturer made some valuable suggestions for the encouragement of original research in India, among which may be mentioned the establishment of post-graduate scholarships and fellowships by Indian Universities. One of the great drawbacks in the prosecution of physical research in India is the want of suitable laboratories. It is to be hoped that this vital want, which stands in the way of original investigations in science, will soon be removed. Scientific men in Europe are greatly interested in the recent contributions to science made by India, and they welcome Indian investigators as their co-workers in advancing natural knowledge.

FROM the *Gardener's Chronicle* we learn with regret that Baron Constantin Ettingshausen, the palæontologist and botanist, has died at Graz, at the age of seventy-one. Deceased was originally a doctor of medicine, but devoted all his time and energies to botany and palæontology. He was engaged for some time in arranging palæontological collections in the British Museum (Natural History). He was the author of several works on botanical subjects, and wrote a large number of papers, which were published in the *Proceedings* of the Royal Society, and of other learned bodies.

WE notice also with regret the announcement of the death, at Headington, near Oxford, of Mr. Henry Boswell, the eminent bryologist. Mr. Boswell had not only studied the mosses of Britain, but had an intimate acquaintance with foreign species, and his knowledge was utilised by many correspondents in different parts of the world. In his early days his attention was directed to the study of flowering plants, but subsequently he developed a greater fondness for the study of bryology. He possessed a large collection of mosses, which it is hoped will be secured by the University. In recognition of his services to bryological science, Oxford University, in 1887, conferred upon him the honorary degree of Master of Arts.

THE following are among the announcements of the deaths of men of science abroad:—Dr. Nikolai Zdekauer, St. Petersburg, member of the Imperial Academy of Sciences, and distinguished for his work to advance hygiene and the knowledge of epidemics; Herr Alois Rogenhofer, formerly curator of the Imperial Natural History Museum in Vienna; Dr. Hermann von Noerdlinger, formerly professor of forestry in Tübingen University; and Dr. G. D. E. Weyer, professor of mathematics and astronomy in Kiel University.

WE are sorry to see the announcement in the *Times* that Prof. Charles Tomlinson, F.R.S., a successful and distinguished teacher and writer in both science and literature, died on Monday, at his residence in Highgate, in his eighty-ninth year. He was elected on the Council of the British Association for the Advancement of Science in 1864, a Fellow of the Royal Society in 1867, a Fellow of the Chemical Society in the same year, and was one of the founders of the Physical Society. He was for many years Lecturer on Experimental Science at King's College, held the Dante Lectureship at University College, 1878–80, and was Examiner in Physics to the Birkbeck Institution. In science he was the author of many handy text-books on natural philosophy, meteorology, and natural history, and contributed numerous papers, the results of original research, to the *Transactions* of the Royal and Chemical Societies. In 1854 he edited "Tomlinson's Cyclopædia of Useful Arts, Mechanical and Chemical, Manufactures, Mining, and Engineering." In biography he wrote the lives of Smeeton, Cuvier, and Linnæus, and the notices of scientific men in "The English Cyclopædia of Biography." In literature he was the author of "The Inferno of Dante, translated into English Tierce Rhyme"; "Herman and Dorothea, translated from the German Hexameters of Goethe into English Hexameters"; "Essays, Old and New"; "The Chess Players' Manual," and many contributions to literary and scientific magazines.

AN announcement, which will arouse a good deal of interest among biologists, was made at a recent meeting of the New York Academy of Sciences. Mr. Bashford Dean reported that he had obtained a fairly complete series of embryos of *Bdellostomum*, including upwards of twenty stages from cleavage to hatching. *Bdellostoma*, as the name is usually written, is a form very closely allied to *Myxine*, the hag-fish, which is abundant off the northern coasts of Europe. Hitherto the development of the Myxinoids, with the exception of one stage of segmentation, has been entirely unknown, though many European zoologists have spent much time and labour in unsuccessful endeavours to obtain material for its investigation. The developing eggs of *Bdellostoma*, which are quite similar to those of *Myxine*, were obtained by Mr. Dean in the course of collecting operations carried on at Puget Sound, California, by a party of zoologists from Columbia University, New York, in the summer of last year. A number of the eggs and larvæ of a form allied to Chimæra were also secured. The results of the study of this material will be of the greatest interest and importance. After the mystery of the reproduction of the eel had been explained by Grassi, there were only two well-marked types of vertebrates whose development still baffled investigation; and the difficulties in these two cases appear to have been at last overcome.

THE first number of the second decade of the *Kew Bulletin of Miscellaneous Information* is almost entirely devoted to a "List of Kew Publications, 1841–1895." It consists of more than eighty pages of titles of independent publications, or of very numerous and important contributions to journals, containing a record of work done either by members of the Kew staff, or by others working in the Gardens, the Herbarium, or the Jodrell Laboratory. In addition to the *Icones Plantarum*, *Botanical Magazine*, and other serials issued from Kew, the list includes all the more important Colonial Floras, such as Bentham's of Australia, Hooker's of New Zealand, Grisebach's of the British West Indies, Seemann's of the Fiji Islands, Baker's of Mauritius, Hooker's of British India, and others; also important monographs, such as Baker's of the Fern-Allies, Bromeliaceæ, and Amaryllideæ, Massee's of the Myxogastres, many of the orders in Martius's *Flora Brasiliensis*, &c. When to this is added such works of first-class importance as Sir W. J. Hooker's "Genera Filicum," Hooker and Bentham's "Genera Plantarum," Hooker's "Himalayan Journals" and "Botany of the *Erebus* and *Terror*," Bentham's "Handbook of the British Flora," Hooker's "Student's Flora," Hemsley's "Handbook of Hardy Trees, Shrubs, and Herbaceous Plants," and, to crown all, the "Index Kewensis," it will be seen that there is some justification for the statement that the list "represents a volume of work which probably is not surpassed by that of any other institution in the world."

We learn from the February *Journal* of the Royal Geographical Society that the first gold medal of the American Geographical Society of New York, the fund for which was given by the late General Cullum, has been awarded to Lieut. Peary, and was presented to the explorer at the recent annual meeting of the Society. Of Mr. Peary's many services to the geography of the Arctic regions, that which is selected as the special ground for the award is his delineation, in 1892, of the coast-line of Greenland and the consequent demonstration of its insular character. Lieut. Peary, after returning thanks for the medal, proceeded to unfold his plan for a new expedition, which is to aim at reaching the North Pole, a plan which has already been endorsed by the New York Society. Having given it as his opinion that the results of recent expeditions serve to show that the only feasible route by which to attain the North Pole is that by Smith Sound and the north-west coast of Greenland, he pointed to the important work to be done in those regions, in addition to the reaching of the Pole. He proposes the raising of sufficient funds to enable the work of the expedition to be continued, if need be, for ten years. It is proposed to go to Sherard Osborn Fjord, or further, in a ship manned by a minimum crew, and—having taken on board *en route* several picked families of Eskimo—the people and stores would be landed, and the ship sent back. During the autumn sledging season he would advance supplies north-eastward along the coast by short and rapid stages, taking advantage also of the brilliant winter moons. The party itself would follow stage by stage, living like the Eskimo in snow-houses, so that in early spring it should have already reached, with the bulk of its supplies, the northern terminus of the North Greenland Archipelago, whence, ice conditions being favourable, a dash for the Pole would be made with the lightest possible equipment, with picked dogs and two of the best Eskimo. Each succeeding summer the ship would attempt to reach the base, whence the series of *caches* already formed at each prominent headland would supply a line of communication with the advanced station.

THE Seismological Committee of the British Association has just sent out a circular inviting co-operation in an endeavour to extend and systematise the observation of earth-movements. The cost of an instrument to record such movements, with photographic material to last one year, is about 50*l.* The first object the Committee has in view is to determine the velocity with which motion is propagated round, or possibly *through*, the earth. To attain this, all that is required from a given station are the times at which various phases of motion are recorded; for which purpose—for the present, at least—it is considered that an instrument recording a single component of horizontal motion will be sufficient. Other results which may be obtained from the proposed observations are numerous. The foci of submarine disturbances, such, for example, as those which from time to time have interfered with telegraph cables, may possibly be determined, and new light thrown upon changes taking place in ocean beds. The records throw light upon certain classes of disturbances now and then noted in magnetometers, and other instruments susceptible to slight movements; whilst local changes of level, some of which may have a diurnal

character, may, under certain conditions, become apparent. Persons who are willing and able to participate in the work of obtaining such records, are requested to communicate with the Seismological Committee, British Association, Burlington House, London, W.

WE have received from the National Observatory of Athens the numbers of the *Bulletin Mensuel Seismologique* for August, September, and October last. The number of shocks observed in Greece during these three months are respectively 24, 27, and 24. The majority were very slight, and were felt by only a few persons; but the large number recorded is a good test of the valuable work done by the new Geodynamic Section, which the Director of the Observatory has placed under the charge of Dr. Papavasiliou.

DR. JOHANNES BUCHWALD contributes to the *Mittheilungen von Forschungsreisenden und Gelehrten aus den deutschen Schutzgebieten* a paper on the distribution of plants in West Usambara, from observations made by himself during six months' residence at Muafa, and on three journeys extending over the whole of the neighbouring mountain region. The floras of the plain and mountain districts are dealt with under separate headings, and special attention is devoted to the species which, while properly belonging to the one region, make their way into the other.

A PLAN, on a large scale, of the newly-founded New York Botanical Garden, accompanies the *Bulletin* of the Garden for January. The same number contains also reports of the Committees to which were entrusted the plans for the arrangement of the Gardens and Museum, as well as Prof. Britton's address on Botanic Gardens, given at the last meeting of the American Association, which comprises a slight sketch of the principal botanic gardens of the world.

THE *Botanical Gazette*, the leading botanical journal of the United States, commences the present year with a staff of three editors and thirteen associate-editors, representing the four American Universities of Harvard, Cornell, Michigan, and Missouri, and the following foreign centres:—Geneva, Padua, Berlin, Paris, Tōkyō, Bonn, Cambridge (England), Copenhagen, and Stockholm. The inclusion of Tōkyō in the list is indicative of the great activity of biological studies in Japan. Besides original articles, the *Gazette* has admirable abstracts of important papers published in foreign botanical journals.

A BIBLIOGRAPHY of the published writings of Dr. P. L. Sclater, F.R.S., has been published as *Bulletin* 49 of the U.S. National Museum. Many years ago the publication of a series of bibliographies of representative American naturalists was begun by the Museum, and five bulletins of this type had been published previous to the present one. Though the original intention was to confine the series to the work of naturalists carrying on researches in America, Dr. Sclater has paid so much attention to American ornithology that it was considered most desirable to widen the scope and devote a bulletin to his contributions to the subject. The result of acting upon this decision is a bibliography running into 135 pages, arranged chronologically, and in lists of new families and genera described, new species described, and species figured.

THE meteorological observations made at Rousdon Observatory, Devon, during 1895, and the reduction of observations for the lustrum 1891–95 and the decade 1886–95, are contained in a volume which Mr. Cuthbert E. Peek has just distributed. In addition to the statistical contents, the report contains a valuable account of a comparison of the records of a Kew pattern Robinson anemometer with those of a pressure-tube anemometer. The sum of the mean hourly velocities obtained from the pressure-tube record was compared with the recorded run of the caps of the Robinson anemometer for each month. The results are, on the whole, very consistent, and show that, for almost all velocities, the pressure-tube record amounts to only about eleven-fifteenths of the mileage recorded by the Robinson. In other words, assuming the velocity shown by the pressure-tube to be correct, the factor of the Robinson should be 2·2. Mr. Peek thinks that the true factor of the Kew pattern, or standard size, Robinson anemometer is sufficiently close to 2·2 as to make it safe to accept that value for getting the real velocity of the wind from its records.

A VERY attractive guide to Stockholm, containing numerous illustrations, and useful hints to tourists, has been issued by the Swedish Tourists' Club. The guide should be seen by all who propose to visit the beautiful capital of Sweden during the forthcoming summer, when the great Scandinavian Art and Industry Exhibition will be open.

A GENERAL index to the first fifty volumes of the *Quarterly Journal* of the Geological Society, has been compiled and edited by Mr. L. L. Belinfante, Assistant Secretary of the Society. Part i., comprising the letters from A to L, has just been published. It need hardly be said that the complete index will be of great service to geologists. Another useful publication issued by the Geological Society is the author's and subject index to the geological literature added to the Society's library during last year.

THE first number of *The Middlesex Hospital Journal* has been sent to us, and it is a very creditable production. Among the contents is a paper, by Mr. Henry Morris, on the diagnosis and treatment of stone in the bladder. Referring to the use of Röntgen rays in the diagnosis of renal and vesical calculi, it is shown that calculi compound of uric acid and urates are not likely to be revealed by the rays, especially if the rays have to pass through the adult skeleton to reach them. On the other hand, stones which have phosphates or phosphate or oxalate of lime in their composition can be discovered by Röntgen rays. A portrait of the late Mr. J. W. Hulke, F.R.S., reproduced by the Swan Electric Engraving Company, forms a striking frontispiece to the *Journal*.

THE Museums Association exists for "the promotion of better and more systematic working of museums throughout the kingdom." In order to promote this object, the Association meets in a different town each year. Last year it met at Glasgow, and the report of the proceedings at the meeting, edited by Mr. E. Howarth and H. M. Platnauer, has lately been published by Messrs. Dulau and Co. To curators of museums the volume is invaluable. Among the subjects dealt with in it are type specimens in botanical museums, by Mr. E. M. Holmes; colour tinting and its application to microscopic work, by Dr. G. Bell Todd; descriptive geological labels, by Mr. Herbert Bolton; electrotypes in natural history museums, by Mr. F. A. Bather; chemistry in museums, by Mr. G. W. Ord; and suggestions made by Huxley in 1868 for a proposed natural history museum in Manchester, contributed, with Huxley's original pen and ink sketches, by Mr. W. E. Hoyle.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Miss M. Hewens; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. C. W. Hutchings; a Yellow-shouldered Hangnest (*Icterus tibialis*) from Brazil, presented by Mr. W. H. St. Quintin; a Ring-tailed Coati (*Nasua rufa*) from South America, deposited; two Painted Frogs (*Discoglossus pictus*), South European, received in exchange; four Varied Field Mice (*Isomys variegatus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

PRIZES IN ASTRONOMY.—The Belgian Government has offered a sum of 300,000 francs, without distinction of nationality, on the occasion of the Exhibition to be held this year in Brussels, to the authors of the best solutions of some important questions selected by special Committees of the different Sections. The problems which more especially interest us, namely those on astronomy, are as follows (the values of the 1st, 2nd, and 3rd prizes being 900, 600, and 500 francs respectively).

A. Construct an apparatus by which relative measures of the value of g on board ship may be made.

B. Construct an apparatus to show the effects similar to those of the germination of the canals on Mars, and which may explain the actual observed phenomena.

D. Invent a means by which planetary details may be photographed as clearly as they can be observed.

E. Find a method by which the sun can be observed at any time as if it were totally eclipsed.

F. Indicate a sure method of determining the amount and direction of movement of the solar system.

Prizes of 300 and 200 francs are offered for the authors of the best answers to the following :—

A. Investigate, from the point of view of computation of astronomical observations, whether the formulæ of Laplace, relative to the movement of rotation of the earth, are or are not more exact than those of Oppolzer.

B. Improve in some way the measures made with the meridian circle (elimination or determination of personal error, instrumental corrections, &c.).

C. Write a critical essay on the fundamental principles of mechanics, and differentiate between what is purely rational and what is in the domain of experience.

D. Improve in some point the actual state of our knowledge of cosmogony.

E. Improve our knowledge of gravity, either by a new discussion of old observations or by new methods.

F. Improve the magnetic chart of any country, either by a fresh discussion of old observations or by the use of new ones.

G. The theory of the motion of rotation of the terrestrial pole.

H. Give complete theoretical formulæ for the variation of latitudes, and determine by them the periods theoretically.

I. Investigate whether a new term for the secular acceleration of the moon can exist.

DOUBLE STAR MEASURES.—Vol. x. Part 1 of the publications of the *Washburn Observatory* contains the observations of double stars, made with the 40 cm. Clark equatorial telescope of this observatory between the years 1892 and 1896. The stars selected were for the most part well-known binary systems in rapid motion; but additions have at times been made, among which were eleven stars of very slow relative motion included in the list of circumpolar stars selected by Otto Struve for observation as comparison stars. Only nights on which the "seeing" was sufficiently good for the employment of high magnifying powers were used. The director, Mr. George Comstock, states, with regard to the possible error due to the position of the observer's head: "I have uniformly held my head in such a position during the observations that the line joining the eyes was either parallel or perpendicular to the line joining the star images." The measurements of distance were made by placing the micrometer threads upon the discs of the stars. In the cases of very close and difficult stars, another method was adopted, applied only when the distances were below $0''·5$. A discussion of the probable errors shows that for distances less than $0''·60$, a single estimate of distance may be assumed constant and equal to $\pm 0''·040$. The coordinates of the stars in the list are referred to the equinox of 1880·0.

LUNAR PHOTOGRAPHS.—The February number of the *Bulletin de la Société Astronomique de France* contains an interesting article, by M. Camille Flammarion, on lunar photography. The reader will find there some excellent reproductions of the Paris negatives, the latter equalling, if not surpassing, any photographs obtained. A magnificent phototype, from a photograph taken February 14, 1894, shows the moon nine days from the lunation, Copernicus standing out magnificently clear on the terminator. All the details are wonderfully sharp, and the contrast leaves little to be desired. M. Loewy is to be congratulated on the high state of efficiency which he has attained in his photographic investigations of the lunar surface.

REPORT ON THE CORAL REEF AT FUNAFUTI.[1]

Prefatory Note by Prof. T. G. Bonney, F.R.S., Vice-Chairman of the Committee.

IN presenting, as desired by the Committee, Prof. Sollas's report on the attempts to ascertain, by boring, the structure of the atoll of Funafuti and on other investigations simultaneously undertaken, I avail myself of the opportunity of expressing the gratitude which is felt by its members to our friends in New South Wales, who have given such real and substantial help, especially by the loan of machinery and skilled workmen, in putting the project into execution; and among them chiefly to Prof. Anderson Stuart (who has been practically another Secretary in Australia), Prof. Edgeworth David, Mr. W. H. J. Slee (Chief Inspector of Mines), and Sir Saul Samuel (the Agent-General of the Colony in England). I shall venture also to acknowledge gratefully the services of Captain Field and the officers of H.M.S. *Penguin*, and the unstinted labour which has been given by Mr. W. W. Watts, our Secretary in London, in carrying out our plans. In conclusion, may I express, speaking for myself, my earnest hope that another attempt will be made to determine the true structure of an atoll. I think, however, that our experience on this occasion shows that the attempt can be much more easily made, and with a far greater probability of success, if Australia instead of England be the base of operations, and I trust that before long the colony of Sydney will initiate an expedition, and we shall co-operate with them as cordially as they have done with us.

Report of Prof. Sollas, F.R.S.

H.M.S. *Penguin* having come to anchor in the lagoon of Funafuti on the afternoon of Thursday, May 21, Captain Field at once landed with Lieut. Dawson, Ayles (the foreman of the boring party), and myself, and we proceeded to make arrangements for our work on the island. A site for boring was chosen near the sandy beach of the lagoon, conveniently situated for the landing of gear, less than half a mile to the south and west of the village of Funafuti, and near the village well, which supplies a small amount of brackish but drinkable water. The work of landing was commenced the next morning, and completed by May 26. The erection of the boring apparatus was at once taken in hand, and on June 2, twelve days after our arrival on the island, all was in readiness for commencing operations. On June 3 the 6-inch tubes were driven into the sand, and by June 6 they had been advanced 30 feet; the 5-inch pipes were then entered, and everything made ready for inserting the diamond crown and commencing to drill on Monday, June 8. On June 10 it was arranged that the work should proceed by shifts, so that the drilling might be carried on continuously day and night. During the first shift the crown had been advanced 20 feet, making the total depth then attained 52 feet 9 inches; during this shift, fragments of highly cavernous coral rock were brought up in the core barrel from a depth of between 40 and 50 feet.

On June 11, a depth of 85 feet having been reached, it was found necessary to ream the hole preparatory to lining, and by June 15 the necessary reaming and lining had been completed. Up to this, although we had been somewhat disappointed at our slow rate of progress, occasioned partly by the unfavourable nature of the ground and partly by the frequent failure of our machinery, we had anticipated nothing worse than the possibility of finding our allotted time exhausted before we had reached a depth of 1000 feet; but now, on setting the crown to work, it very soon ceased to advance, and Ayles shortly afterwards came to me to announce that, in his opinion, the boring was a failure. Nevertheless, some further progress was subsequently made, and on Tuesday, June 16, a depth of 105 feet was attained. It then became once more necessary to ream and line the hole. Attempts to ream were continued all through Wednesday and Thursday, but without success; sand poured into the hole, and the reamer could not be driven through it. Efforts were made to remove the sand by a sand-pump, but proved unavailng, the sand flowing in faster than it could be pumped out. Ayles assured me that it was impossible to descend another foot, and that he considered further labour as time and money thrown away. We decided therefore to

[1] "Report to the Committee of the Royal Society appointed to Investigate the Structure of a Coral Reef by Boring." By Dr. W. J. Sollas, F.R.S., Professor of Geology in the University of Dublin. Received December 1896. Read, February 11, 1897.

abandon this borehole, and to recommence operations on another site, if possible in solid rock.

The structure of the ground passed through in the abandoned borehole was as follows (Fig. 1):—

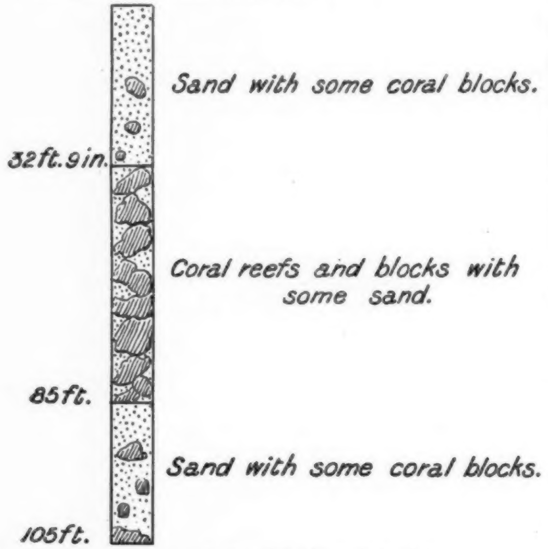


FIG 1.—Section of the abandoned borehole.

Although I knew of many places where solid rock forms the surface of the ground, it was very difficult to find one to which we could transport our machinery; the difficulties of landing on a rocky shore rendered several promising spots inaccessible by sea, while the absence of wheeled vehicles or even wheels, and the nature of the ground, seemed to put transportation by land out of the question.

At last, however, Mr. Hedley pointed out to me a portage called Luamanif, and used by the natives for dragging their canoes from the lagoon to the seaward side of the island, which at this place is very narrow, about 70 yards across. As this seemed a good landing-place I submitted it to the consideration of Captain Field, who, after a personal examination, agreed that we might safely make use of it. Ayles and his party were then set to work to sink trial-pits on the line of the portage; one of these, situated 70 feet from the high-water mark on the seaward face of the reef, was sunk 12 feet through sand and blocks of coral, when operations were brought to a close owing to the influx of sea-water at high tides. Two other pits were then commenced nearer the sea and a little to one side (north) of the portage, at the margin of the solid platform of rock, which extends down to the growing edge of the reef, and which is covered by the sea at high water. These passed through sand and fragments of coral. In the most northern of the two pits the sand was somewhat consolidated, and so, proceeding a few yards further north, as far in that direction as it would have been possible to transport our machinery, we opened another pit, which was sunk for a depth of 11 feet through fragments of coral, crystalline coral limestone, and partly consolidated sand. The bottom of the pit was 2 feet below the seaward margin of the reef, and as we were not inconvenienced by an influx of sea-water, and Ayles was of opinion that the rock would "stand," we decided to make our new venture at this spot (Fig. 2). Taking into consideration the difficulties of transporting our apparatus, I do not think a more favourable locality could have been chosen; it was close to the very edge of the rocky platform, which is so hard that Darwin, speaking of a similar platform in the case of another reef, says, "I could with difficulty, and only by the aid of a chisel, procure chips of rock from its surface"; and as near the sea as it was prudent, or even possible, to go. Indeed, we had at first some doubt as to whether our pumping pipes would "live" in the surf of the ocean margin, and feared that the high-water spring tides might inundate the shaft; our fears in these respects, however, proved to be groundless.

Captain Field and myself were impressed with the need of additional boring apparatus, and he proposed that Ayles should go to Sydney to see if it could be procured. I gave much anxious consideration to this project, and discussed it with my colleagues, Messrs. Hedley and Gardiner, and with Ayles. The information I received from Ayles was not encouraging. He stated that we should require a complete equipment of lining tubes, from 10 inches down to $2\frac{1}{2}$ inches in diameter, that 10-inch tubes were not to be had in Sydney, and that even if we succeeded in obtaining all the appliances we required, the success of the boring would even then by no means be assured.

For a doubtful result I did not feel justified in incurring the certain increase in our expenditure which a journey to Sydney would have involved; the question of time had also to be considered, for had Ayles gone to Sydney we should on his return have been commencing our boring at or after the date the Committee had considered it would have been completed. Finally, it appeared that the new locality we had chosen for our work offered fair prospects of success.

The shaft already sunk to a depth of 11 feet was then timbered with Pandanus logs, and arrangements made for carrying down a hole by jumping with a 6-inch chisel. Ayles spoke of getting as far as 50 feet by this means, and then lining the hole with 6-inch tubes, but after sinking 4 feet he declared it impossible to proceed further in this way; the chisel could not be made to continue sinking in a straight line, the labour was too exhausting, and progress very slow. It was decided, therefore, to begin boring, Ayles being very hopeful, as the hole "stood" well. On Thursday, June 25, we accordingly made arrangements to shift our boring gear to the new site, and by Saturday, June 27, this work was completed, chiefly by native labour, at a cost of about £10. The boilers were rolled along the beach, the rest of the machinery taken by water, and all subsequently dragged, rolled, or carried across the portage. Lieut. Waugh lent us valuable assistance, during the absence of the *Penguin*, in this work.

Boring was commenced on Friday, July 3, and by 5 o'clock we had sunk another 4 feet; progress then became rapid, and on Saturday evening, when work was knocked off, we had descended in all 46 feet. Very little "core" was obtained, however, and at times the boring bit met with very little opposition as it advanced, seemingly passing through a vacant space. Since the water pumped into the hole no longer flowed out above, but found its way out by some communication with the sea below, it was impossible to determine whether or not some sand might have been present. It was clear, however, that the coral rock through which the "bit" advanced was highly cavernous.

On Monday the hole became filled with fallen fragments and some sand; it was evident, therefore, that the sides would not hold, and so recourse was had to lining; by Thursday, July 9, the hole had been reamed and lined down to 45 feet, and the work of boring was resumed. On pumping, we had the satisfaction of seeing the water flowing out of the top of the hole; but our joy was short-lived, for, on Monday, June 13, the water was again lost. On Tuesday, July 14, we had reached 65 feet, passing for the last 20 feet through sand and coral. Subsequently we attained a depth of 72 feet, and could then proceed no further. We worked all Thursday and Friday with the sand pump, but with no success; the bottom of the hole was surrounded by quicksand containing boulders of coral, and as fast as the sand was got out, so fast it flowed in and faster. The water pumped

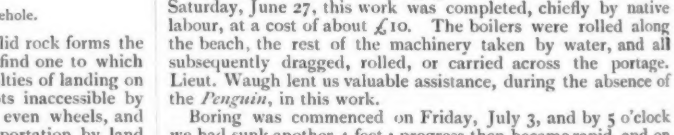


FIG. 2.

down disappeared through the sand, boring and *à fortiori*, reaming was impossible, and the tubes could not be driven owing to the interspersed boulders. Had the tubes been provided with steel driving ends, we might have forced them down; as it was, the effect of driving them was simply to curl in the lower

end. Had we been provided with 4-inch tubes we could have made a fresh start, and might have descended another 30 or 40 feet, bu even then ultimate success would not have been ensured, for the chance of meeting again and again with intermixed sand and coral remained always open, and every such encounter would have required lining tubes of diminished calibre.

Baffled in all our endeavours, and no other part of the island offering more hopeful prospects of success, we had no alternative but to abandon the undertaking, and on July 30 we were taken from the island in the *Penguin* and returned to Fiji. On landing there we had the mortification to learn that additional apparatus was then on the way to Funafuti, our friends in Sydney having, with great generosity, at once despatched machinery for driving in sand on receipt of a letter I had sent informing them of the failure of our first borehole. We had had no reason to expect such spontaneous assistance, and even had we been fortunate enough to have remained on the island till the machinery arrived, we should probably not have accomplished the object we had in view, though we might possibly have carried the borehole down to a depth of about 400 feet.

A very free communication must have existed between the borehole and the sea, for whenever a big roller broke upon the reef the rods lifted, and after the lining had been withdrawn, water spurted out of the borehole with the fall of every wave. The open nature of the reef is further indicated by the fact that the sea-water rises with every tide to fill certain depressions, which occur in many places in the middle of the island; as the tide ebbs this water flows away down fissures, often so rapidly as to form little whirlpools.

Wherever I have seen the reef growing it has always presented itself as clumps or islets of coral and other organisms with interspersed patches of sand, and the borings would seem to indicate that it maintains this character for a very considerable depth, and possibly throughout. The structure of the reef appears indeed to be that of a coarse "sponge" of coral with wide interstices, which may be either empty or filled with sand.

As regards the nature of this "sand," it is important to observe that it does not consist of coral débris; this material and fragments of shells forming but an insignificant part of it; calcareous algæ are more abundant, but its chief constituents are large foraminifera, which seem to belong chiefly to two genera (*Orbitolites* and *Tinoporus*). It covers a considerable area of the islands, and has accumulated during the memory of the inhabitants to such an extent as to silt up certain parts of the lagoon. This and the abundant growth of corals and calcareous algæ, such as *Halimeda*, lead to the belief that the lagoon is slowly filling up.

A suggestion has recently been made that more light is likely to be thrown on the history of atolls by a study of ancient limestones in the British Isles than by boring in existing reefs. The first essential, however, for such a study would appear to be a knowledge of the structure of living atolls, for, without this, the identification of others forming a part of the earth's crust, might remain more or less a matter for conjecture. So far as the structure of Funafuti has been proved by borings, it is scarcely what a field geologist might have anticipated, and if deposits of a similar nature and origin should have been encountered in, say, the mountain limestone, it is doubtful whether, previous to the borings in Funafuti, their interpretation would have been easily reached.

While the boring has proved a failure, the other objects of the expedition have been attained with complete success. Messrs. Hedley and Gardiner have made a thorough investigation of the fauna and flora, both land and marine. Dr. Collingwood has obtained a good deal of information of ethnological interest, and we all have brought home a fairly complete collection of native implements and manufactures. A daily record was kept of maximum and minimum temperature, and of the readings of the dry and wet bulb thermometers.

The most important contribution, however, and one that I think must, in certain details greatly modify our views as to the nature of coral reefs, is afforded by the investigations of Captain Field. Never before have soundings, both within and without an atoll, been so closely and systematically made, and the results seem to me commensurate with the care and pains that have been taken to secure them. Four series of soundings, "Sections," as they are termed on board the *Penguin*, have been run from the seaward face of the reef outwards. How close together the soundings were made is shown in the following table, which Captain Field has kindly permitted me to copy from his order book :—

Depth	0— 40	fathoms every	10	yards.
,,	40— 70	,,	20	,,
,,	70—100	,,	30	,,
,,	100—150	,,	40	,,
,,	150—200	,,	50	,,
,,	200—300	,,	60	,,
,,	300—400	,,	70	,,
,,	400—500	,,	80	,,
,,	500—600	,,	90	,,
,,	600—700	,,	100	,,
,,	700—800	,,	200	,,

The profiles obtained by the four series are closely similar, and, as regards one important feature, almost identical. This

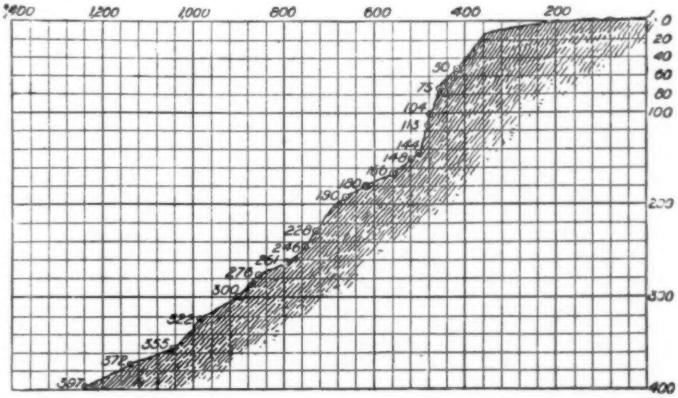


FIG. 3.—Section D—Horizontal measurements in yards; vertical measurements in fathoms. The section is drawn to true scale.

is the sudden change in slope that occurs at or about 140 fathoms. Speaking generally, one may describe Funafuti as the summit of a submerged conical mountain, the base of which, at a depth of 2000 fathoms, is a regular ellipse, 30 miles long by 28 miles broad. It rises with a very gentle slope, which gradually grows steeper as it ascends, till from 400 to 140 fathoms it has an angle of 30°; at 140 fathoms an abrupt change occurs, and the slope becomes precipitous, making an angle of from 75° to 80° for the greater part of its course, till it passes into the shallow flats of the growing reef. It is difficult to resist the impression that it is the upper 140 fathoms (840 feet) which represents the true coral reef. A convex curvature of the profile between 166 and 261 fathoms is probably a talus, produced by an accumulation of coral débris (Fig. 3).

The conical mountain below the 140 fathoms line, with its parabolic slope, is suggestively similar to a volcano; but, if so, its crater must have been immense, 10 miles across at least. A volcano, 12,000 feet in height, with a crater 10 miles in diameter, is, however, not an unknown phenomenon; within the limits of the Pacific we may cite Haleakala, in Maui, Sandwich Islands, as closely comparable.

A part of my work while on the island was the construction of a geological sketch map, part of which is shown in Fig. 4; its interest chiefly centres in a broad expanse near the Mission Station, where the two narrow limbs of the island meet, or, if it be preferred, whence they extend. Towards the seaward side this broad corner is occupied by a mangrove swamp, the floor of

which is formed by a dead coral reef, constituted almost wholly of two species, one a massive Porites, and the other *Heliopora cærulea*. For a great part of the day this floor lies bare and dry, the frayed ends of the Heliopora standing like broken reeds, 6 inches above its surface, and the great clumps of Porites forming a series of stepping-stones of equal height. Neither of these corals stands long exposure to the air; on Funafuti they require constant submergence, and we are thus led to regard their upper surface as marking what was at one time the level of low tide in the swamp; but since the present level of low tide is below the level thus indicated, some change must have occurred in the level of low tides. Not necessarily an elevation of the reef: Darwin has admirably discussed this explanation, and it is quite conceivable that some change in local conditions, such as the exclusion of the sea by the growth of the hurricane beach, may

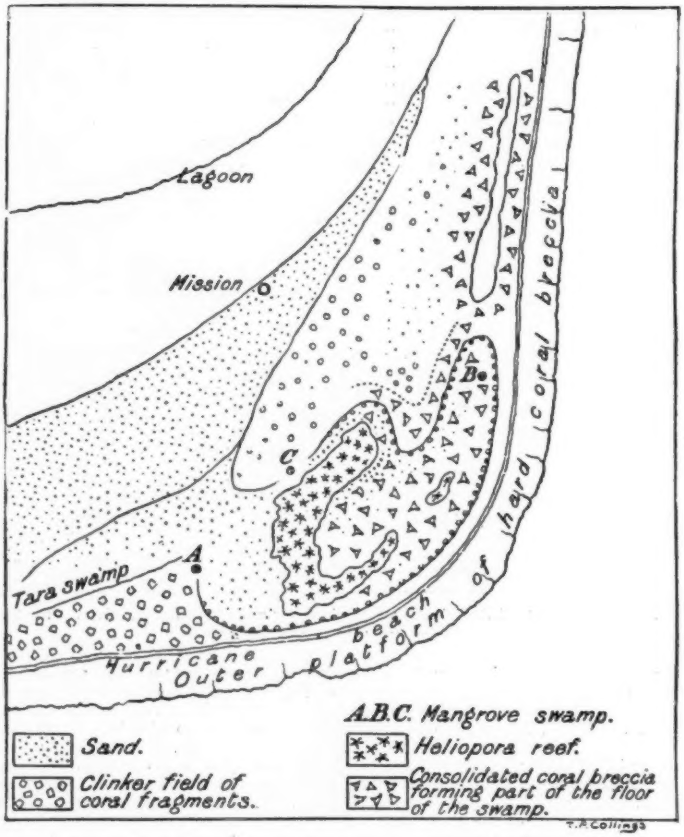
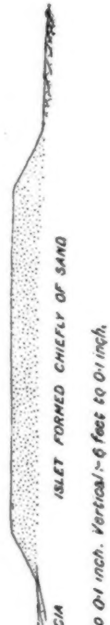


FIG. 4.—Corner of Funafuti, showing Mangrove Swamp and Heliopora Reef.

have produced a local alteration in the height of the tides. The swamp communicates with the sea by pits in its floor, which enter subterranean channels running seawards. These passages are so narrow that the tide rises and falls in the swamp much more slowly than in the open sea. To determine whether any change of level has taken place, it thus becomes necessary to compare the highest and lowest water level of the swamp with that of the sea or of the lagoon. I accordingly levelled across the island from the lagoon to the sea, crossing the swamp on the way, and found that the high-water level at spring tides is 1 foot 10 inches below high-water (spring tides) of the lagoon, so that given free access of the sea, the Heliopora reef would be covered 1 foot 10 inches deeper than at present; but it is now submerged from 10 inches to 2 feet 2 inches at high water springs, and would accordingly be submerged from 2 feet 8 inches to 4 feet, with free access of the sea. The range of spring tides is at least 6 feet, as I learn from Lieut. Dawson, but I am not quite sure that an extreme range of 9 feet 8 inches has not been observed. Taking, however, the smaller number, it becomes clear that for a considerable part of the day, the ree would be exposed to the air. It is not likely that under these conditions the corals would continue to live, and, I think, therefore, that the reef must have undergone some slight elevation, to the amount, perhaps, of 4 feet. This conclusion is in accordance with Dana's view, and is supported by observations on some other features of the island, such, for example, as the occurrence of an interrupted line of low cliffs, sometimes passing into a series of pinnacles, generally about 4 feet in height, as measured from low-water level. In the annexed section (Fig. 5) the cliffs are further from the land than is usually the case. These cliffs consist of a consolidated breccia of coral fragments, and are now in process of denudation, as is

SECTION THROUGH THE ISLET OF PAVA, FUNAFUTI.



Scale. Horizontal:- 4 fathoms to 0·1 inch. Vertical:- 6 feet to 0·1 inch.

FIG. 5.

the coral platform which extends from them, up to and under the hurricane beach. This breccia was probably formed and cemented together when the reef stood at least 4 feet lower than at present, and was produced by the breakers driving fragments of corals from the seaward edge of the reef into the lagoon, as they are now doing over the isthmuses, submerged at high tide, which connect the several islets of the atoll together.

If it should prove true, as I do not doubt, that one of the latest episodes in the history of the reef has been an elevation of, say, 4 feet, then in the immediately antecedent stage, the reef must have been a wash, or, perhaps, wholly submerged, and the present terrestrial fauna and flora mnst have reached it subsequent to its elevation, as sea drift, or have been introduced by human agency.

In conclusion, I would add that to myself the soundings obtained by Captain Field appear to support Darwin's theory of coral atolls; there remains, however, one very important branch of the subject which stands in need of renewed investigation, and this is the bathymetrical limit to coral life. Not till I had obtained a close acquaintance with the difficulties of dredging on the steep side of an atoll did I recognise on how frail a basis our accepted conclusions rest. It is a task difficult enough to get up corals from the lagoon in comparatively shallow water; from the sides of the reef it is well-nigh impossible. To obtain dead corals from great depths proves little; living corals are generally found with dead associates, and the latter are the more readily detached and brought to the surface. The weight of the evidence we already possess is admittedly in favour of a comparatively shallow bathymetrical limit, but much remains to be done before we can speak of any limit as definitely ascertained.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Thursday and Friday, the 4th and 5th inst., the annual general meeting of the Institution of Mechanical Engineers was held in the theatre of the Institution of Civil Engineers, in Great George Street. The President (Mr. E. Windsor Richards) occupied the chair. The Secretary read the report of the Council, from which it appeared that the Institution continues to grow in numbers and to accumulate capital, it having an income of over 7000*l*. a year, and an expenditure of about 5000*l*., the accumulated excess of receipts over expenditure being now over 46,000*l*. The Institution will shortly have a house of its own. Hitherto its offices have been a suite of rooms on the ground-floor of one of the buildings in Victoria Street, Westminster, a rent of 710*l*. being paid. The new building will be situated at the Storey's Gate to St. James's Park—that is to say, just at the bottom of Great George Street. The plans, which were exhibited at the meeting, show a handsome building, and as the front looks right on to the Park, the Mechanical Engineers will be very pleasantly housed. There will be a large lecture theatre, so that the Institution will no longer have to depend on the hospitality of the parent engineering Institution for a place to hold its meetings. Although this will naturally be a convenience, it will be with regret that the pleasant association between the two Institutions of host and guest will be severed. In looking at the new building of the Institution of Civil Engineers and the house of the Mechanical Engineers, now springing into existence only a few yards off, one cannot but think with regret what might have been done had the various Institutions devoted to engineering interests joined forces, and built a really commanding building, worthy, at the same time, of being a public monument to applied mechanical science. The Institutions of Civil Engineers, Mechanical Engineers, Naval Architects, Iron and Steel, and Electrical Engineers are all prosperous societies. Of course the Civil Engineers and Mechanical Engineers overshadow the others in wealth and influence, but they would have lost nothing by joining forces, for the accommodation afforded in the building could have been appropriated according to the amount contributed. There were naturally some difficulties in the way, but these could have been overcome. However, the chance of Great Britain, the birthplace of steam engineering, having a worthy home of engineering science is now past, and we can only look with appreciative interest on the efforts of the different societies to house themselves independently, but in a relatively modest fashion. The new building of the Mechanical Engineers will be finished in eighteen months. It has been kept back by difficulties with the London County Council.

There were three papers set down for reading at the meeting. They were:—

(1) Fourth Report to the Alloys Research Committee. By Prof. W. C. Roberts-Austen.

(2) Partially immersed Screw Propellers for Canal Boats, and the Influence of Section of Waterway. By Henry Barcroft.

(3) Mechanical Propulsion on Canals. By Leslie S. Robinson.

The Report to the Alloys Research Committee alone calls for any extended notice.

Mr. Barcroft's paper was read; and it had, however, the good effect of calling forth from Mr. S. W. Barnaby a very clear exposition of some points in connection with screw propulsion; and also a speech from Mr. Thornycroft, which, together, will serve to put the matter in a true light in the *Proceedings*.

The report of Prof. Roberts-Austen gave, firstly, some general considerations respecting the present position of the research; secondly, it dealt with the copper zinc alloys, known as the brasses; and thirdly, with certain relations between the fusibility and strength of alloys; and this involved considerations as to the constitution of alloys generally. An account was also given of an experimental investigation which was undertaken with a view to measure the molecular mobility of solid and molten metals, known as diffusion.

In the series of researches, of which a part was described in the paper, the author had attempted to find how far the properties of metallic masses are dependent on atomic movement and molecular grouping. This part of the paper contains so striking a lesson on the value of scientific investigation of problems of a constructive or industrial nature, that we will quote Prof. Roberts-Austen's introductory passage to this section in full. It ought to be unnecessary to do so, but the self-called "practical man"—who is really the most short-sighted and unpractical man in existence—has been so much in evidence of late, and has received so much support from a section of the technical press, that a corrective may well be administered.

Prof. Roberts-Austen, referring to the course followed in the report, says:—

"The mechanical properties of alloys of definite series of metals have assumed less prominence than the principles which affect alloys generally; and the result has been that, although the course adopted hardly needs justification, the practical bearing of the investigation may have seemed to be somewhat remote. The devotion of years of labour, for instance, to tracing the relations of alloys to saline solutions, would appear at first sight to be of less practical importance than determining the mechanical properties of alloys by the aid of testing machines. Establishing the analogy between alloys and saline solutions has, however, been eminently fruitful in practical results; for it has enabled the mechanical properties of alloys to be explained, and even to be predicted. It has been easy to show that the property of liquation possessed by saline solutions while freezing—which consists in rejecting a certain quantity, often very minute, of a fluid portion of the mass, and distributing or relegating it to a definite position in relation either to the mass as a whole, or to the individual crystals—is now recognised as being of fundamental importance in determining the mechanical properties of varieties of iron and steel and of alloys generally. This subject of liquation will always be identified with the work of the Alloys Research Committee, and its history is interesting. Its origin is French (Levol, *Annales de Chimie et de Physique*, vol. xxxvi., 1852, p. 193; vol. xxxix., 1853, p. 163); but much experimental work in this connection was published more than twenty years ago in a paper of my own (*Proceedings* of the Royal Society, vol. xxiii., 1874-5, p. 481); and the present Report will contain references to the latest phases of the inquiry, which may also be claimed as the outcome of the labours of this Committee. Attacking the problem of the constitution of alloys from the atomic point of view has, moreover, been fruitful in results; for it has enabled the influence exercised by the relative atomic volumes of the alloyed metals upon the mechanical properties of the mass of metal to be clearly revealed."

The original problem proposed for consideration of the Alloys Research Committee was, "Are the mechanical properties of metals and alloys connected with their atomic volumes?" This

question, the author says, "has been definitely answered in the affirmative."

In dealing with the copper zinc alloys, the author reminds us that it is seldom an alloy solidifies sharply or at one temperature, as water does. There are generally at least two freezing points; and in the industrial brasses, which never contain more than 45 per cent. of zinc, only three of the freezing points were referred to at first, although the scientific interest of the rest was considered later on. The chief point of interest in the paper was the consideration of the eutectic alloys. Of the several breaks in the curves of cooling points of most alloys, the first usually represents the falling out of a more or less pure metal, or some compound of the metal, from the cooling alloy. A second and sometimes a third break indicates the solidification of a eutectic alloy, that is a fusible metallic or "mother liquor," which solidifies at a definite temperature. In the copper zinc series there are several of these eutectic alloys.

Guthrie introduced the designation "eutectic" alloy to denote the most fusible alloy of two or more metals, comparing it to the mother liquor of a salt solution, which remains fluid after the bulk of the salt has crystallised out. The recording pyrometer shows that as regards alloys the case is really far more complicated. Many alloys consist, when fluid, of more than one solution; and each of the several solutions leaves, on cooling, a solid deposit and a fluid mother liquor. These mother liquors, however, do not usually unite with one another; and a complicated set of conditions is established, when the temperature has fallen sufficiently low for the whole mass to become solid. Each of these metallic mother liquors is a eutectic alloy. Some alloys—the lead-tin for instance—are of a simple character, and when fluid have only one eutectic alloy, that is, the deposits fall out from a single mother liquor. All the alloys which are used for the sake of their strength appear to be highly complicated. Thus in the alloys of copper and zinc there are at least four eutectic alloys, and in the copper-tin series there are at least six.

The composition of eutectic alloys does not in general correspond to simple atomic proportions of the component metals, and the author considers there are theoretical reasons for supposing that a eutectic alloy cannot possibly be a chemical compound. It should be noted that in the cooling curves of some alloys, solidification, as shown, takes place over a somewhat long range of temperature. The point at which one constituent begins to crystallise has been called the higher freezing point, and the temperature at which the eutectic alloy solidifies out is called the lower freezing point. These two points are indicated by separate evolutions of heat. That the lead-tin series has more than one freezing point, is illustrated in a familiar way which has considerable industrial importance. A plumber making a "wiped joint" uses a solder containing 66 per cent. of lead, and its pasty condition is due to the fact that it has two widely separated points of solidification, the alloy consisting of granules of solid lead in a fluid mother liquor.

The facts above given lead up to a consideration of the mechanical properties of brasses, and the relation of these properties to the freezing point curve. In dealing with this part of the subject, the author had recourse to a series of diagrams exhibited on the walls of the theatre. Without the aid of these it will be impossible for us to treat the matter at all completely, even from the point of view of a brief abstract. Indeed the report—which is of great length—is so full of matter that we cannot hope to do more than give a few of the most prominent facts, which may serve to afford our readers an idea of its scope. Those interested in metallurgical research will naturally go to the original for fuller information. The method of investigation pursued was to heat an alloy in a steel cylinder and squeeze out the eutectic by hydraulic pressure; the temperatures being noted, until finally a comparatively infusible residue is left. The several portions were then analysed, and the results of the analyses were given in an appendix. The results were discussed by the author in detail; the dominant fact disclosed being that the maximum strength in the series of cast brasses occurs in the alloy containing 60 per cent. of copper. This alloy has practically only one freezing point. Further additions of zinc cause a rapid diminution of tensile strength and extensibility. The explanation given was, that in these alloys the compound CuZn is unaccompanied by free copper. In a series the summit of the curve representing extensibility coincides with the first appearance of the upper eutectic which falls out from the alloy that contains 71 per cent. of copper. This eutectic probably consists of a mixture of copper with the compound CuZn. The mixture of these soft and hard substances produces great strength, as is evident from the fact that the strongest alloy of the series consists almost entirely of this eutectic; but the presence of the eutectic naturally diminishes the extensibility of a mass which contains more than a small amount of it.

The addition of small amounts of iron to certain alloys of copper and zinc (Sterro and Aich's metal) is next discussed by the author. The reason of the remarkable increase of strength thus produced has hitherto been obscure, but the facts are disclosed by a comparison of the cooling curves given in the report. The alloy selected contained 61 per cent. of copper and 39 per cent. of zinc; and in the absence of iron there was a low eutectic point in the cooling curve at about 450° C. or 842° F., evidently due to the presence of a eutectic, which constituted a source of weakness. The added iron, however, entered into combination with the eutectic, forming with it a less fusible compound; for a cooling curve then showed that the low eutectic point was absent, and that the source of weakness had been removed. Moreover, the main solidifying point of the Aich's metal was higher than that of the brass: which in itself is an indication of augmentation of strength. The facts thus established are probably of wide importance in metallurgical practice; and where strength is desired, it would appear to be advisable, whenever a cooling curve reveals the presence of a low eutectic in an alloy, to add some third metal which will diminish the fusibility of the eutectic. Aich's metal, when compared with brass of the same composition but without the 1½ per cent. of iron, is greatly superior in strength. If it owes this superiority to the fact that a eutectic alloy does not remain fluid as the mass cools, it might be anticipated that the relatively high tenacity of Aich's metal would be maintained at temperatures at which the brass would become weak.

We have not space to follow the author further in his valuable and interesting research. He shows how the action of impurities is made clearly evident in connection with eutectic points, and has some most instructive remarks on the diffusion of metals, the latter a most important section of the report. He also gives an account of improvements in the recording pyrometer by which great delicacy in recording is secured. The report concludes with a comparison of the thermo-junction with the air thermometer.

A good discussion, opened by Sir William Anderson and Sir William White, followed the reading of the report; but we have preferred to devote the space at our disposal to the report itself, as containing the most important matter. It may be said, however, that the tone of the discussion was entirely favourable to the report, its practical importance and value being dwelt upon both by the engineers and metallurgists present.

DR. YERSIN, AND PLAGUE VIRUS.

IN view of the importance which attaches to Dr. Yersin's discovery of the plague virus and its anti-toxin, the following notes on his work may be of interest.

When a youth of twenty, Yersin had the rare good fortune to obtain an entrance to the Institut Pasteur. The extraordinary ardour with which he devoted himself to his work, rapidly won for him the admiration and respect of all his colleagues. When little more than a student, Roux signalled him out to assist him in those important researches on the toxin of diphtheria which have since become so memorable, and which were communicated to the scientific world under the joint names of the master and his pupil.

While at Tonkin, in the spring of 1894, he received the request from the French Government to proceed to Hong Kong to study the plague which had recently broken out there. Yersin started off on his mission, and arrived in Hong Kong a few weeks after the plague had commenced its terrible career in that city—a career which had already claimed the lives of 300 Chinese, and which was yet to exact a tribute of over 100,000.

Yersin describes how, on reaching Hong Kong, he found the authorities busy rapidly erecting temporary hospitals, the existing accommodation being quite inadequate to cope with the widespread dimensions of the epidemic. He obtained permission to erect a small hut within the precincts of the principal hospital; and there, in a concentrated plague atmosphere, he

took up his quarters, and hastily improvising a laboratory, commenced his investigations.

So far the plague had confined itself to the insanitary Chinese quarters of the city; and Yersin mentions that the wretched cabins occupied by the natives were often not only without windows of any kind, but were sunk below the level of the ground, which, combined with the shocking overcrowding which prevailed, converted such dens into plague-incubators of the most fulsome and dangerous character.

In these infected districts, one of the first things which attracted Yersin's attention was the extraordinary number of dead rats which lay about in all directions in the houses as well as in the streets; but, on inquiry, he soon learnt that this rat-mortality was a well-known forerunner of the plague, that the latter usually attacks animals such as rats and mice, and in the country districts swine and buffalos, before it touches human beings. An examination of these dead rats showed that their symptoms differed in no way from those which characterise the plague in man, and the extreme susceptibility of these animals furnished Yersin at once with a valuable means of tracking out the virus. His first step was to make careful examinations of the bubonic material present in the tumours which accompany the disease, and here he discovered immense numbers of a short bacillus which appeared to be almost exclusively in possession of the field. These he found were readily stained, and could be cultivated with ease in the usual bacterial media. Further investigation showed that these same bacilli were invariably present in the ganglia and liver and spleen of plague patients; that they were, however, rarely to be found in the blood, and then but in small numbers, and usually only in rapidly fatal cases a short time before death.

Healthy rats and mice inoculated with pure cultures of this bacillus succumbed to the typical plague symptoms; and Yersin had thus accomplished the first step in his investigation—the identification of the specific virus of plague. Yersin was at first of opinion that rats were the principal disseminators of the disease, for healthy mice shut up with a dead plague-stricken rat, rapidly developed the disease and succumbed; but he noticed later the curious fact that, in the little room where he carried out his *post-mortem* examinations, immense numbers of dead flies were scattered about in all directions. He, therefore, determined to ascertain if this wholesale slaughter of flies had any connection with plague infection; so taking some of these insects, and first removing the head, wings and feet, he pounded up their bodies in broth. An examination later of the liquid exhibited masses of bacilli closely resembling the now familiar plague microbe; to place their identity beyond doubt he inoculated some of this broth into mice, with the result that the latter died of plague. That flies materially assisted in the spread of the disease was thus established.

With the slender accommodation and primitive means at his disposal, it was impossible for Yersin to further pursue his investigations, and prepare a plague anti-toxin, and he, therefore, forwarded cultures of his bacillus to the Institut Pasteur, and from here, in the course of the following year, was published the memoir describing the production of the anti-plague serum which is now being so urgently requisitioned for service in India. The bacillus was found to be pathogenic for not only rats and mice, but for the other animals of an experimental laboratory, rabbits and guinea-pigs.

The attempt was first made to vaccinate these animals by means of the toxin, but filtered cultures of the bacillus produced no effect whatever; so that the plan was adopted of heating cultures to 58° Centigrade, and inoculating the dead bacilli. If the latter are injected in sufficient quantities, they are capable of killing the animal; but if a smaller quantity of the liquid containing them is employed, then it acts as a vaccine, and the animal is protected from a subsequent lethal inoculation of the virus, and its serum subsequently acquires protective properties. From success with small animals the attempt was made to immunise large animals, such as horses. For this purpose virulent plague-cultures, capable of killing a mouse in two days, were employed, and the liquid containing these living microbes was injected into the horse's veins. The reaction was rapid and intense, and lasted a whole week, after which the fever abated, and the animal slowly recovered. A long interval—twenty days—was allowed to elapse before a second injection was attempted; but this time, although an equally virulent culture was employed, in the same quantity as before, the symptoms were less pronounced, and passed away more rapidly, and it was found possible to both gradually increase the quantity and diminish the interval between the several injections. At the end of six weeks the first trial was made of the curative properties already attained by the serum, and the results were regarded as extremely satisfactory and encouraging. To confer immunity to plague infection on a mouse, it required $\frac{1}{10}$th of a cubic centimetre of serum, administered twelve hours *before* the virus was injected; to cure animals after plague infection, 15 cubic centimetres of serum were required to be inoculated twelve hours *after* the virus had been introduced. The large quantity of serum necessary in these first experiments for curative purposes, was due to the short time during which the immunising process had been carried on. It will be remembered that in diphtheria the time required to train a horse's serum up to the proper protective pitch is a question of months, and in the case of anti-venomous serum a matter of as much as fifteen months; thus a treatment of six weeks only is a very short time for the serum to exhibit immunising properties. That the most remarkable therapeutic value attaches to anti-plague serum as now elaborated at the Institut Pasteur in Paris, is shown by the success which has recently followed its application in undoubted cases of plague at Amoy, by Yersin, now Director of a Pasteur Institute at Nha-Trang in Annam.

In conclusion, it may be asked, How long is England to rest content to knock as a humble suppliant at the door of foreign institutes for assistance when overtaken by disaster, as is now the case in India? Why should Paris supply the means for relieving the suffering of our fellow-subjects in India?

The answer and reasons for that answer are, alas! but too well known to require repetition here; and we can only hope that in the future, at present dim and obscure, the barriers which now so formidably impede medical progress in this country may yield before the enlightened pressure of public opinion.

G. C. FRANKLAND.

THE "BAZIN" ROLLER BOAT.

IN NATURE of December 3, 1896, we gave a short notice of the new roller-boat the *Ernest Bazin*. From a paper recently read at the Society of Arts by M. Émile Gautier (*Journal* Society of Arts, January 22), the following further particulars are taken.

The *Ernest Bazin* was launched a few months ago at Saint-Denis, and was then taken down the Seine to Rouen, where she is being fitted with her engines and machinery. As soon as these are completed an experimental trip will be made across the Channel, and it is anticipated that the vessel will in the course of about six weeks be anchored in the Thames. This experimental vessel has a displacement of 280 tons; its length is 131 ft. 3 in., and width 38 ft. 9 in. The framework and hull are supported on six lenticular hollow wheels 32 ft. 10 in. in diameter, about one-third of which will be immersed. The engines, cargo, cabins, &c., are placed on a platform resting on a framework carried on the axles of the wheels. The engines are constructed to develop 750 horse-power; 550 of which will be used for the propeller, and 200 horse-power for driving the three pairs of wheels. With this power an ordinary steamer of a similar tonnage would not steam more than 18 or 19 knots. It is expected that the *Ernest Bazin* will attain double this speed. The principle on which the vessel is constructed is the substitution of the rolling motion of great wheels for the ordinary gliding motion of the hull of the vessel through the water, in order to minimise friction. An ordinary ship with its hull gliding through the water represents the disc pushed forward without a rotary motion being imparted to it. As it is compelled to cut the water in front of it, and to drive it back longitudinally, it would soon cease to move forward did it not receive a fresh impulsion at every moment. If, however, the vessel were supported by revolving buoys, it is contended that it would possess all the advantages of the disc, to which a rotary as well as a forward motion is given. The effort, instead of being exercised longitudinally, is exercised partially downwards, vertically, so that the resistance is reduced in a considerable degree.

As the result of calculation the rotary speed of the wheels has been made one half greater than the speed of translation.

In the discussion which followed the reading of the paper, the speakers, while declining to prophesy as to the results to be attained, seemed to be of opinion that the difficulty of construction would increase very rapidly with the increase in size, owing to the great strain which would be imposed on the

platform in rough weather, and that to obtain the necessary strength the weight would become excessive.

Practically the carrying part of the structure rests on six floating vessels coupled together by a framework. It does not follow that because this principle as applied to the lightly-constructed canoes used by the natives of the Polynesian Islands is successful, that it could therefore be applied to the enormous structure required for an Atlantic liner. The *Calais Douvre* and other coupled boats which have been built for the cross-Channel passage, have certainly not proved a success.

M. Bazin, the inventor, is an engineer well known in France for the originality of his ideas, and for the invention of a submarine machine that served for the attempt to raise the Spanish galleons sunk in Vigo Bay; also for inventions in connection with gold-washing machinery, dredgers, cranes, &c. His roller-boat will no doubt attract a great deal of attention when it arrives in the Thames.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The degree of Doctor of Science will be conferred on Dr. Nansen at a special congregation to be held at 1 p.m. on March 16.

Prof. E. E. Barnard, of the Yerkes Observatory, Chicago, is to exhibit his photographs of the Milky Way, and other celestial objects, in the Lecture Theatre of the Cavendish Laboratory, at 4 p.m. on February 20.

Dr. A. C. Haddon is this term giving two well-attended classes (one elementary and one advanced) in physical anthropology at the Anatomy School.

An examination for scholarships and exhibitions in natural science and engineering will be held at Trinity College on March 15. Details may be learned on application to the tutors.

THE Cornwall County Council have had to further increase the salary attached to the lectureship on fisheries to £350 per annum, to enable them to secure a competent instructor.

AT a meeting of the Council of the Royal College of Surgeons, on Saturday last, the following resolution was adopted (subject to the approval of the Royal College of Physicians): "That the Royal College of Physicians of London and the Royal College of Surgeons of England, in full accord with their previous action, express the earnest desire that her Majesty's Government will, at the earliest opportunity, reintroduce a Bill for the reconstitution of the London University by statutory commission on the general lines of the report of the Cowper Commission, and do assure the Government that such a course will have their approval and support." It was further resolved that if the Royal College of Physicians adopted the foregoing resolution, copies of it should be forthwith forwarded to the Lord President of the Council, Mr. Balfour, and the Senate of the University of London.

A PLEA for the establishment of a National University at Washington is made in *Science* of February 5. It is suggested that the University should be developed from the national institutions already existing at Washington. "Workers in the different Government divisions and others having the proper preliminary education could, on presenting a thesis showing original work and passing an examination, receive the doctorate of philosophy, and this would qualify them as a civil service examination for promotion. The present Commissioner of Education, and perhaps the Regents of the Smithsonian Institution, could govern the University. Examiners could be appointed from leading representatives of science and learning, who would meet yearly for a week of convocation in Washington. We believe that, without radical changes, and with nominal expense, there could be established at Washington a National University likely to become the world's greatest University."

AN annual report, received a few days ago, tells us that the past year was more than usually interesting in the history of the Glasgow and West of Scotland Technical College, as being the centenary of the foundation of Anderson's College, which received its charter of incorporation from the magistrates of the City of Glasgow on June 9, 1796. Besides being the oldest member of this composite institution, the interest attaching to Anderson's College—apart from the fame of its medical school, now a separate institution—lies in the fact that it was the progenitor of mechanics' institutions and the pioneer of technical education in this country. The record of successes of past and present students testifies to the soundness of the instruction given. The College is extending its operations rapidly over the West of Scotland, and, as its name implies, it is now more than a Glasgow institution. We notice that Mr. G. F. Scott Elliot has been appointed lecturer in botany, in succession to the late Mr. Thomas King, who occupied that position for many years.

THE fifth annual report of the Technical Instruction Subcommittee of the City of Liverpool, which has reached us, shows that the high standard of efficiency was maintained during 1896. Most educationists will agree with the Chairman, who says, in his prefatory remarks, that "it will be a considerable advantage to the cause of higher education generally when it is recognised, by legislative authority, that specialised technical instruction can only properly be carried on as part of a general scheme of secondary education, and when means are provided for encouraging and developing general secondary education without attempting to force it too soon towards specialisation." The detailed report of the Director shows that no part of the legitimate work of a local system of technical instruction has been neglected. The teaching of science and modern languages has been further improved and developed in the secondary schools, special attention being very properly directed towards the provision of every convenience for the necessary amount of practical instruction in chemistry and physics. Side by side with this provision for young boys and girls, we find an efficient system of evening classes in commercial and technical subjects for young men who have started upon the serious work of life. The Committee have shown their appreciation of their good fortune in having a University College at hand by helping it to the extent of £1700 during the past year, which has been marked by a much needed extension of the chemical laboratories, and by the establishment of a new Natural History Museum.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, January.—"On the stability of a sleeping top" is the abstract of a lecture delivered by Prof. Klein before the Society at the Princeton meeting, October 17, 1896. It will be remembered that Prof. Klein delivered four lectures "On the theory of the top," at the sesquicentennial celebration of the University. In these latter an attempt was made to simplify the formulæ for the motion of a top by turning to account the methods of the modern theory of functions. The later lecture before us considers from the same standpoint a much more elementary question, viz. the stability of a top rotating about an axis directed vertically upwards. The point of support is supposed to be fixed. When the rotation is very rapid the behaviour of the top is as if its axis were held fixed by a special force. Some interesting results are arrived at.—Bibliography of surfaces and twisted curves, by Dr. J. E. Hill, consists mainly of extracts from a paper read before the Society in May last. It attempts to represent a compilation and classification of all articles, with certain exceptions, upon these surfaces and curves which have been published during the present century. The paper itself should be, judging from these extracts, extremely useful to students.—Linear differential equations is a review, by Prof. M. Bôcher, of Schlesinger's "Handbuch der Theorie der Linearen Differentialgleichungen," and, like the previous work by Prof. Bôcher in the *Bulletin*, is thorough. The writer's conclusion is that though the book fails to meet some of the demands which it seems to him may fairly be made of a handbook, it is certain to fill an important place in a mathematical library, owing to the great amount of information which it contains in accessible form.—Messrs. R. W. Willson and B. O. Peirce furnish a table of the first forty roots of the Bessel equation $J_0(x) = 0$ with the corresponding values of $J_1(x)$. This is a paper which was presented to the Society at its summer meeting, September 1, 1896.—The final article, not counting the notes and publications, is entitled "Notes on the Theory of Bilinear Forms," and is by Prof. H. Taber. It was read at the November meeting.

Wiedemann's Annalen der Physik und Chemie, No. 2.—On the dissipation of electricity from a conductor into the air, and on the influence exerted by an increase of temperature of the conductor upon this process, by A. Oberbeck. A thin wire, to which an electric charge is imparted, loses its charge more

readily in air when hot than when cold. The difference between a positive and a negative charge is also more strongly marked at high temperatures, the negative charge being more rapidly dissipated.—Point discharge potentials in air and hydrogen, by K. Wesendonck. The quantity of negative electricity discharged into hydrogen is greater than the quantity of positive electricity discharged at the same potential, but the initial discharge potentials are not necessarly different.—The atomic theory in natural science, by L. Boltzmann. The conception of the atom cannot be finally superseded by the differential equation as applied to a *continuum*, since the latter is itself based ultimately upon the conception of a discrete structure, even in such applications as Fourier's theory of thermal conductivity. The atom has also the advantage of greater immediate clearness and picturesqueness over the differential equation, whether it really exists or not.—On discharge rays, and their relation to kathode and Röntgen rays, by M. W. Hoffmann. Discharge rays are contained in the spark discharge in air, hydrogen, and nitrogen at ordinary or low pressures. They exert no photographic action, but may be discovered by their property of imparting luminescence to solid solutions of manganese sulphate in gypsum when heated to a temperature below incandescence (thermo-luminescence). They are intercepted by mica, quartz, fluorspar, and other solids, unless produced at low pressures. They proceed in straight lines, and are not deflected by a magnet. They differ from ultra-violet light in their power of penetrating air, and not fluorspar. They are not reflected by solids.—Platinised electrodes and determinations of resistance, by F. Kohlrausch. The solution used by Lummer and Kurlbaum for making bolometers, viz. one part platinum chloride, to 0·008 lead acetate and 30 water, gives a platinum black, which is very useful for platinising electrodes. It facilitates the use of smaller electrodes for alternate-current resistance measurements, and gives a well-marked minimum of telephone effect.—Electric moment of tourmaline, by W. Voigt. This was determined by breaking the tourmaline into fragments, and was found to be 33·4 C.G.S. units.—A new formula for spectrum waves, by J. J. Balmer. The author substitutes for the infinite geometrical progression in Kayser and Runge's formula a closed term, and gives the frequencies for the lines of each series in the form $A - B/(n+c)^2$.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 21.—"On Reciprocal Innervation of Antagonistic Muscles." Third Note. By C. S. Sherrington, F.R.S., Holt Professor of Physiology, University College, Liverpool. Received December 29, 1896.

If transection of the neural axis be carried out at the level of the crura cerebri in, *e.g.* the cat, there ensues after a somewhat variable interval of time a tonic rigidity in certain groups of skeletal muscles, especially in those of the dorsal aspect of the neck and tail and of the extensor surfaces of the limbs. The details of this condition, although of some interest, it is unnecessary to describe here and now, except in so far as the extensors of the elbow and the knee are concerned. These latter affect the present subject. The extensors of the elbow and the knee are generally in strong contraction, but altogether without tremor and with no marked relaxations or exacerbations. On taking hold of the limbs and attempting to forcibly flex the elbow or knee a very considerable degree indeed of resistance is experienced, the triceps brachii and quadriceps extensor cruris become under the stretch which the more or less effectual flexion puts upon them, still tenser than before, and on releasing the limb the joints spring back forthwith to their previous attitude of full extension. Despite, however, this powerful extensor rigidity, flexion of the elbow may be at once obtained with perfect facility by simply stimulating the toes or pad of the fore foot. When this is done the triceps enters into relaxation and the biceps passes into contraction. If, when the reflex is evolved, the condition of the triceps muscle is carefully examined, its contraction is found to undergo inhibition, and its tenseness to be broken down synchronously with and indeed very often accurately at the very moment of onset of reflex contraction in the opponent prebrachial muscles. The reaction can be initiated in more ways than one, electrical excitation of a digital nerve or mechanical excitation of the sensory root of any of the upper cervical nerves may be employed; I have seen on one occasion a rubbing of the skin of the cheek of the same side effective.

Similarly in the case of the hind limb. The extensor muscles of the knee exhibit strong steady non-tremulent contraction under the appropriate conditions of experiment. The application of hot water to the hind foot then elicits, nevertheless, an immediate flexion at knee and hip, during which not only are the flexors of those joints thrown into contraction, but the extensors of the knee joint are simultaneously *relaxed*. Electric excitation of a digital nerve or of the internal saphenous nerve anywhere along its course will also initiate the reflex.

January 28.—"On the Capacity and Residual Charge of Dielectrics as affected by Temperature and Time." By J. Hopkinson, F.R S., and E. Wilson. Received December 15, 1896.

The major portion of the experiments described in this paper have been made on window glass and ice. It is shown that for long times residual charge diminishes with rise of temperature in the case of glass, but for short times it increases both for glass and ice. The capacity of glass when measured for ordinary durations of time, such as 1/100th to 1/10th second, increases much with rise of temperature, but when measured for short periods, such as $1/10^6$ second, it does not sensibly increase. The difference is shown to be due to the residual charge which comes out between 1/50,000th second and 1/100th second. The capacity of ice when measured for periods of 1/100th to 1/10th second increases both with rise of temperature and with increase of time; its value is of the order of 80, but when measured for periods such as $1/10^6$ second, its value is less than 3. The difference again is due to residual charge coming out during short times. In the case of glass, conductivity has been observed at fairly high temperatures and after short times of electrification; it is found that the conductivity after 1/50,000th second electrification is much greater than after 1/10.000th, but for longer times is sensibly constant. Thus a continuity is shown between the conduction in dielectrics which exhibit residual charge and deviation from Maxwell's law and ordinary electrolytes.

February 4.—"On the Gases enclosed in Crystalline Rocks and Minerals." By Prof. W. A. Tilden, F.R.S.

From the time of Sir Humphry Davy it has been known that many minerals contain gases as well as liquids enclosed in cavities, which are often large enough to be visible to the unaided eye. The liquid sometimes consists of water or saline solutions, occasionally of mineral naphtha, and not unfrequently of carbon dioxide, which is recognisable by its great expansibility and total disappearance when the temperature is raised to about 31° C.

The presence of gases other than nitrogen and carbon dioxide in natural crystals had not been observed, save in one or two isolated cases, until two years ago, when helium was discovered in certain minerals by Ramsay.

In the course of experiments undertaken with the object of ascertaining, if possible, the condition in which this element, remarkable for its chemical inactivity, is contained in these minerals, I was led to the observation that granite when heated in a vacuum gives off several times its volume of gas, which is combustible, and which consists largely of hydrogen and carbonic oxide. I now find that these two gases are contained, more or less abundantly, in all the crystalline rocks, and, together with carbon dioxide and small quantities of nitrogen and marsh gas, are apparently enclosed in fine cavities which permeate the crystals of quartz, felspar, and other mineral constituents.

Of twenty different rocks examined—granite, gneiss, gabbro, schist, or basalt of different geological ages and from widely different localities—all yielded gas in which hydrogen is present, and is usually the preponderant ingredient of the mixture. The total bulk of the gases extracted, varied from a volume equal to 1·3 times the volume of the rock to 17·8 times its volume. Lava also gave gas, though in smaller quantity, and this also contained hydrogen. Graphite, quartz, beryl and tinstone, as examples of definite minerals associated with the older rocks, gave a similar result.

To account for the large proportion of hydrogen and carbonic oxide in these gases, we must suppose that the rock enclosing them was crystallised in an atmosphere rich in carbon dioxide and steam, at the same time in contact with some easily oxidisable substance, probably a metal or metallic carbide, at a moderately high temperature. No free oxygen has been found in any

of these gases, neither has helium been detected. This latter substance seems to be confined to minerals which contain the heavy metals, such as uranium and thorium, and at present it has not been found in any simple silicate.

Physical Society, February 12.—Special General Meeting.—The chair was taken by Captain Abney, who, as retiring President, referred to some of the changes which had occurred in the Society during the past year. The annual subscription had been raised, but a satisfactory number of new Fellows had been enrolled. The Society had lost two by death. A good deal of work had been done in the direction suggested by the discoveries of Röntgen.—The Treasurer, Dr. Atkinson, then presented his report and balance-sheet for the year 1896. There was evidence of improvement in the financial position, but there was still a deficiency to be met. Profits from sales of publications had been small; it was desirable to reduce the price of the volumes of "Collected Papers of Joule and Wheatstone," and to call the attention of physicists to these valuable records of classical work. Mr. Walker suggested that physical laboratories, especially those in London, should be visited by Fellows of the Society, with a view to comparing notes as to the construction of apparatus; professors of colleges and other institutions should be invited to appoint visiting days for this purpose.—Votes of thanks were passed to the retiring President, Council, and Officers, and also to the Council of the Chemical Society for the use of their rooms at Burlington House.—In replying, Captain Abney said that the coming year would probably bring about further improvements in the system of abstracting and indexing, by co-operation with other Societies at home and abroad. He then read the list of Council and Officers for the year 1897–8. President, Shelford Bidwell, F.R.S.; Vice-Presidents who have filled the office of President: Dr. Gladstone, Prof. G. C. Foster, Prof. Adams, The Lord Kelvin, Prof. Clifton, Prof. Reinold, Prof. Ayrton, Prof. Fitzgerald, Prof. Rücker, Captain Abney. Vice-Presidents, Major-General E. R. Festing, L. Fletcher, Prof. Perry, G. Johnstone Stoney. Secretaries: T. H. Blakesley, H. M. Elder. Foreign Secretary (new office), Prof. S. P. Thompson. Treasurer, Dr. Atkinson. Librarian, C. Vernon Boys. Other members of Council: Walter Baily, L. Clark, A. H. Fison, Prof. Fleming, R. T. Glazebrook, Prof. A. Gray, G. Griffith, Prof. Minchin, Prof. Ramsay, J. Walker. The newly-elected President, Mr. Shelford Bidwell, then took the chair, and an ordinary meeting was held. Mr. Blakesley read a paper by Mr. H. H. Hoffert, "On the use of very small mirrors with paraffin lamp and scale." For the mirrors of reflecting instruments the author prefers small rectangular strips of microscope cover-glass, chosen thin and plane. These are first silvered and then cut to shape by a splinter of diamond embedded in wax. They are about 8 mm. long, by 1·5 mm. broad, and are suspended so that their longest sides are vertical. Rectangular mirrors suspended in this way are lighter, and have less inertia than round mirrors of equal aperture. A paraffin-lamp flame placed edgewise to the mirror gives sufficient illumination. The image of the flame is focussed on the mirror by a lens midway between them, it is a right, vertical line, and thus conforms to the shape of the mirror. A scale is fixed upon a screen between the lens and lamp; and the screen has a circular aperture just below the centre of the scale, provided with a vertical cross-wire. The relative position of screen and lens is adjusted so that an image of the wire is formed upon the scale after reflection at the mirror. Mr. Boys said he had frequently used small mirrors constructed as described by the author, and he could not see what was new in the method, except that a paraffin lamp had been found sufficiently bright for the purpose. It is desirable to diminish inertia by choosing extremely thin glass. Microscope cover-glasses are generally supplied in squares or discs very fairly equal in size; if they are dealt out on a table like a pack of cards, their relative thickness can be judged by the note produced as they fall. Flatness can be estimated nearly enough by balancing them one by one upon the knuckle nearly level with the eye, and observing the reflection of an illuminated straight edge, such as a window bar. All rejected glasses should be broken. The good ones can be further examined by a telescope and artificial star. A common "writing" diamond is best for cutting the thin plates. Special care must be taken not to distort the mirror in fixing to the suspended system. If liquid shellac is used in the attachment, distortion will certainly occur, at any rate if it is applied throughout the whole length of the mirror. The best way is to make the attachment at a mere point, near the top of the mirror; using a speck of shellac as viscous as possible, and heating, if necessary, by radiation, not by conduction. Mr. Boys thought that a reflecting prism near the mirror might be used in certain cases where a paraffin lamp with its inevitable vertical flame was required for horizontal projections. For general purposes, Mr. Boys prefers some such arrangement as the following: If the source of light is a point, a lens is employed, forming an image of the source upon the mirror. (If the source of light is a surface, this lens is evidently superfluous.) The cross-wire is stretched near to the lens on the side towards the mirror. It is now necessary to focus the cross-wire upon the scale, and this is best done by a plano-convex lens fixed as near as possible to the mirror, with its plane face towards the mirror. The light passes twice through this lens. As it may be necessary to change the plano-convex lens from time to time, according to the distance of the scale, Mr. Boys attaches it with a little vaseline to a strip of plate glass in front of the instrument. One advantage of such an optical system is that it allows the instrument to be set up in the same position, with respect to the scale, at all times. Dr. Thompson pointed out that Mr. Hoffert had obtained his results using only *one* lens, by properly choosing the position of the cross-wire.—A vote of thanks was given to the author, and the meeting adjourned until February 26.

Entomological Society, February 3.—Mr. Roland Trimen, F.R.S., President, in the chair.—Mr. F. Bates, Mr. D. D'A. Wright, and Mrs. E. Brightwen were elected Fellows of the Society.—Mr. Champion exhibited an extensive series of Coleoptera collected by Mr. R. W. Lloyd and himself in the Austrian Tyrol, and containing about 450 species, including 35 of Longicornia, and about 20 of Otiorrhynchus. He also exhibited about 85 species of Coleoptera from Cintra, Portugal, collected by Colonel Yerbury, the most interesting of these being *Carabus lusitanicus*, F.; also two specimens of the rare *Zeugophora flavicollis*, Marsh., from Colchester. Mr. Tutt showed, for Mr. W. H. B. Fletcher, typical *Zygaena ochsenheimeri*, Zell., from Piedmont, and hybrids between a female of that species and *Z. filipendulæ*. The progeny was fertile *inter se*, the males closely approaching *Z. ochsenheimeri*, the females *Z. filipendulæ* in character. He also exhibited, for Mr. J. B. Hodgkinson, a number of obscure British Microlepidoptera, some of which had been described as new species. The determinations were criticised by Lord Walsingham, Mr. Bower and Mr. Barrett, and the former speaker strongly deprecated the practice of positively recognising or describing obscure species from single or worn specimens, particularly when British.—Mr. Barrett showed specimens of the true *Platyptilia tesseradactyla*, L. (= *P. fischeri*, Zell.) new to the United Kingdom, and taken in Co. Galway.—Mr. McLachlan exhibited cooked locusts (*Schistocerca peregrina*) sold in the market of Biskra, Algeria, and received from the Rev. A. E. Eaton. They were cooked whole, but the abdomen only was eaten. The President, Mr. Barrett, and Mr. Blandford made some remarks on the subject.—A paper was communicated by Dr. A. G. Butler, on "Seasonal dimorphism in African butterflies," which led to a long discussion, chiefly on the so-called "dry-season" and "wet-season forms." Mr. Merrifield stated that he had been unable experimentally to modify the colour and markings of Lepidoptera by variations in humidity. Mr. Tutt believed that Mr. Doherty had obtained "wet season forms" of Oriental species by keeping the pupæ in a moist atmosphere.

EDINBURGH.

Royal Society, February 1.—Lord Kelvin in the chair.—A paper by Dr. J. Clarence Webster, on the changes in the mucosa of the corpus uteri, and in the attached fœtal membranes during pregnancy, was laid on the table. Prof. D'Arcy Thompson described a very simple logical machine.—A paper by Lord Kelvin, Dr. Beattie and Dr. Smolan, on the conductive quality induced in air by Röntgen rays and by violet light, was read. (See page 343.)—Lord Kelvin read a paper on crystallisation according to rule. For example, as the beginning of a crystal forming from molecules moving freely in a solution consider a cluster of 13 balls, one touched by 12 neighbours around it (model shown). This presents 8 triangular beds and 6 square ones, on which a wandering molecule may lie down. Let a rule be that a wandering molecule takes the first square bed which comes in its way, but never takes a triangular bed if

a square one is vacant. The 6 square beds thus become occupied, and an octahedron of 19 balls is formed, each plane face of which is an equilateral triangle of 6 balls with 3 in each edge. Each triangular face presents 4 triangular beds, of which the middle one is shallow, and the 3 around it deep (tried with a probe pin). There being now no square beds, wandering molecules take triangular beds; but the rule (to make the whole assemblage homogeneous and equilateral) must be that only deep triangular beds are eligible. Thus procedure according to rule adds 24 balls, and we have a cluster of 43 balls (model shown), which presents 2 kinds of triangular or 3-contact beds and 12 equal and similar 5-contact beds, but no square beds. The 12 5-contact beds are next to be filled. These give us a cluster of 55 balls (model shown), presenting 6 square faces of 9 balls, with 4 square beds, and 8 triangular faces of 6 balls each. The 24 square beds are next to be filled, and we have a cluster of 79 balls presenting 6 square beds. The next action, according to rule, fills these, and gives us a regular octahedron of 85 balls, with 15 balls in each face and 5 in each edge. Each triangular face contains 16 triangular beds, of which 10 are deep and 6 shallow. To continue the crystallisation, we may suppose all the deep triangular beds equally eligible; and any one of them may be taken by a molecule deposited from the solution, and any one of the 6 equal and similar 4-contact beds between it and neighbours may be taken next. We shall never find any 6-, 7-, 8-, or 9-contact beds formed if the following rule is rigorously observed in continuing the crystallisation. Five-contact beds must be occupied when any are vacant. When none of these remain, 4-contact beds must be occupied, and whenever no 5-contact or 4-contact beds remain, we shall find that we have a regular octahedron. To continue the crystallisation, any one of the deep triangular beds may be taken by a wandering molecule, and the process continued rigorously according to rule. The formation of garnet (rhombic dodekahedron) was illustrated on similar principles by cubic molecules cohering by attractions between "corners" and relatively oriented by quasi-repulsions between edges. Definite laws of force between molecules are suggested, according to which an ideal "complete" crystal of anorthic system, or of any system possessing symmetry, would be a figure of minimum potential energy, and would be of perfectly determinate figure. The number of such configurations would be infinite if the number of molecules were infinite; but practically for a crystal in nature the number that could probably occur might be hundreds, or might be only one. And *the* one configuration of absolutely least potential energy would be a perfect crystal of unique quality.

PARIS.

Academy of Sciences, February 8.—M. A. Chatin in the chair.—On fictitious waterspouts, by M. H. Faye. It is contended that the name of waterspout (*trombe*) has been given to two quite distinct phenomena solely on account of their external resemblance. The true waterspout is in rapid rotation destroying whatever it touches, has a definite direction, moves with a high velocity, has no aspirating power, and comes from above. The false waterspout is distinguished by having a small and uncertain rotation, no definite course, aspirating and ascending movement, and also by the fact that its source of motion is at its base, on the earth.—New researches on the estimation of pyrophosphoric acid, by MM. Berthelot and G. André. The pyrophosphate is precipitated as the magnesium salt by a mixture of magnesium chloride, ammonium acetate and chloride, in the presence of a large excess of acetic acid. The precipitate thus obtained is of complex composition containing sodium and ammonium in addition to magnesium. The composition of the precipitate, moreover, appears to depend upon the amount of washing it has received.—Some historical remarks on metaphosphoric acid, by MM. Berthelot and G. André.—The reduction of nitrates in arable earth, by M. P. P. Dehérain. As the result of the study of the destruction of nitrates in aqueous solutions by denitrifying organisms present in manure, it is shown that the treatment of farm manure with dilute sulphuric acid, previously recommended as a means of destroying denitrifying organisms, is not only expensive, but is, moreover, useless and harmful.—Results of the solar observations made at the Royal Observatory of the Roman College during the second half of 1896, by M. P. Tacchini.—On the zeros of certain analytical functions, by M. Desaint.—On the comparison of the times of oscillation of two pendulums of very nearly the same period, by M. G. Bigourdan. A modification of the arrangement described by M. Lippmann, in which the pendulum clock is replaced by a chronometer, and in which no electrical apparatus is required. —On a new measurement of the coefficient of viscosity of air, by MM. Ch. Fabry and A. Perot. In the absolute electrometer, described a short time ago, equilibrium was found to be only very slowly attained when the distance between the plates was very small (below 75 μ), on account of the viscosity of the air between the plates. The experimental study of the motion produced by the addition of a small surplus charge on the centre of the moving plate has led to a new determination of the coefficient of viscosity of air, $1{\cdot}73 \times 10^{-4}$ at 13° C.—Study of the variations of energy, by M. Vaschy.—On the principle of Avogadro-Ampère, considered as a limited law, by M. A. Leduc.—On the ammoniacal chlorides of silver, by M. R. Jarry. It is shown that solutions of silver chloride in ammonia contain the definite compounds $AgCl.3NH_3$ and $2AgCl.3NH_3$, and the dissociation pressure of the ammonia is the same in aqueous solution as in a vacuum.—On some colour reactions, by M. E. Pinerua. Some colour reactions obtained by the use of β-naphthol-sulphonic-acid. Tartaric, citric, malic, and nitrous acids give characteristic reactions.—On a new method of preparing primary amines, by M. Marcel Delépine. The alkyl chloride, bromide, or iodide is combined with hexamethylene amine, in presence of chloroform, and the product hydrolysed with aqueous hydrogen chloride.—Improvements in the match industry, with especial reference to the health of the operatives, by M. Magitot. The ameliorative measures proposed depend upon a good artificial ventilation, and a careful selection of the operatives, especial stress being laid on the necessity of the latter having no unsound teeth.—On the estimation of potassium bitartrate in wines, by M. Henri Gautier.—On the essence of basil, by MM. Dupont and Guerlain.—The argon and nitrogen in the blood, by MM. P. Regnard and Th. Schlœsing. The gases obtained from a litre of blood gave 20·4 cc. of argon and nitrogen, 0·42 cc. of which was argon.—On the colours of irradiation in short luminous impressions, by M. Aug. Charpentier.—On a new method of electrification, by M. Charles Henry.—Research on the evolution of the *Urnes*, by MM. J. Kunstler and A. Gruvel.—On the gum disease of the cocoa plant, by M. Louis Mangin.—On an apparatus for measuring the refractive indices of minerals in rocks, by M. Fred Wallerant.—On the granite of Pelvoux, by M. P. Termier.—Generalisation of a formula in probabilities, by M. C. Maze.

SYDNEY.

Royal Society of New South Wales, December 2, 1896.—Mr. J. H. Maiden, President, in the chair.—On the presence of a true manna on a "blue grass," *Andropogon annutatus*, Forsk., from Queensland, by R. T. Baker and Henry G. Smith. The substance is found on the nodes of the stems in masses as large as marbles. This appears to be the first time that a substance of this character has ever been described from a grass. Not only is the grass indigenous in Australia, but occurs in tropical Asia and Africa. The manna is sweet, and nearly three parts of it consists of the substance mannite, which, although sweet, is not a sugar. Besides the presence of this interesting substance, a peculiar ferment was discovered in the manna, which apparently has the power to decompose cane-sugar without the evolution of carbonic acid or gases of any kind. It probably belongs to the Sacchoromycetes, and is allied to the ferments of which the yeast plant is a type. It has been isolated from the manna, and was shown at the Society working in a solution of cane-sugar, and also under the microscope. The investigations are not yet completed; but, so far, it appears to be probably the cause of the occurrence of the mannite in the manna, and not only has it the power to alter cane-sugar to mannite, but, with the assistance of yeast, to decompose mannite also—a fact of no little interest. —Remarkable hailstorm of November 17, 1896, in parts of parish of Gordon, by E. du Faur—On the determination of the meridian line by solar observations with any altazimuth instrument, by G. H. Knibbs. The paper dealt with the rigorous mathematical theory of the subject; tables and formulæ, for facilitating the reducing of this class of observations with precision, were supplied. The astronomical conditions of good results were fully dealt with, the matter being of considerable importance in practical geodesy.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 18.

ROYAL SOCIETY, at 4.30.—On the Iron Lines present in the Hottest Stars (Preliminary Note): J. N. Lockyer, F.R.S.—On the Significance of Bravais' Formulæ for Regression, &c., in the case of Skew Variation: G. U. Yule.—Mathematical Contributions to the Theory of Evolution. On a Form of Spurious Correlation which may arise when Indices are used in the Measurement of Organs: Prof. K. Pearson, F.R.S.—Note to the Memoir of Prof. Karl Pearson, F.R.S., on Spurious Correlation: F. Galton, F.R.S.

ROYAL INSTITUTION, at 3.—Problems of Arctic Geology: Dr. J. W. Gregory.

SOCIETY OF ARTS, at 8.—The Mechanical Production of Cold: Prof. James A. Ewing, F.R.S.

LINNEAN SOCIETY, at 8.—On certain Points in the Anatomy and Morphology of the Nymphæaceæ: D. T. Gwynne Vaughan.—The Adhesive Discs of Ercilla spicata, Uog.: T. H. Burrage.

CHEMICAL SOCIETY, at 8.—The Oxidation of Sulphurous Acid by Potassium Permanganate: T. S. Dymond and F. Hughes.—Sodamide and some of its Substitution Derivatives; also Rubidamide: Dr. A. W. Titherley.

CAMERA CLUB, at 8.15. Practical Use of X-Rays: Sydney Rowland.

FRIDAY, FEBRUARY 19.

ROYAL INSTITUTION, at 9.—The Approaching Return of the Great Swarm of November Meteors: Dr. G. Johnstone Stoney, F.R.S.

GEOLOGICAL SOCIETY, at 3.—Annual Meeting.

EPIDEMIOLOGICAL SOCIETY, at 8.

SATURDAY, FEBRUARY 20.

ROYAL INSTITUTION, at 3.—Growth of the Mediterranean Route to the East: W. F. Lord.

MONDAY, FEBRUARY 22.

SOCIETY OF ARTS, at 8.—The Industrial Uses of Cellulose: C. F. Cross.

IMPERIAL INSTITUTE, at 8.30.—The Past, Present, and Future Sugar Supply of the British Empire: C. A. Barber.

SANITARY INSTITUTE, at 8.—Law relating to the Supervision of Food Supply: A. Wynter Blyth.

INSTITUTE OF ACTUARIES, at 7.—Governmental Supervision of Life Insurance in the United States of America: Sheppard Homans.

CAMERA CLUB, at 8.15.—Spitzbergen: E. T. Garwood.

TUESDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 3.—Animal Electricity: Prof. A. D. Waller, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Main Drainage of London: J. E. Worth and W. Santo Crimp.—The Purification of the Thames: W. J. Dibdin.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The *f*/6 Stigmatic Lens and the New Astigmatic Corrector: Thomas R. Dallmeyer.—The Perfected Krömskop: H. E Ives.

ROYAL VICTORIA HALL, at 8.30.—X- and other Rays of Light: Dr. J. W. Waghorn.

WEDNESDAY, FEBRUARY 24.

SOCIETY OF ARTS, at 8.—Reproduction of Colour by Photographic Methods: Sir Henry Trueman Wood.

ZOOLOGICAL SOCIETY, at 8.30.—On the Nature and Origin of the Rauenthal Serpentine: Miss Catherine A. Raisin. (Communicated by Prof. T. G. Bonney, F.R.S.)—On Two Boulders of Granite from the Middle Chalk of Betchworth (Surrey): W. P. D. Stebbing.—Coal—A New Explanation of its Formation, or the Phenomena of a New Fossil Plant considered with reference to the Origin, Composition, and Formation of Coal Beds: W. S. Gresley.

THURSDAY, FEBRUARY 25.

ROYAL SOCIETY, at 4 30.—The following Papers will *probably* be read:—Note on the Dielectric Constant of Ice and Alcohol at very Low Temperatures: Prof. Dewar, F.R.S., and Prof. Fleming, F.R.S.—On the Relation between Magnetic Stress and Magnetic Deformation in Nickel: Dr. E. T. Jones.—On the Relations between the Cerebellar and other Centres (namely, Cerebral and Spinal), with especial reference to the Action of Antagonistic Muscles (Preliminary Account): Dr. Max Löwenthal and Prof. Horsley, F.R.S.—On the Action of Light on Diastase, and its Biological Significance: Prof J. R. Green, F.R.S.—Fragmentation in *Lineus gesserensis*: A. Brown.

ROYAL INSTITUTION, at 3.—The Problems of Arctic Geology: Dr. J. W. Gregory.

SOCIETY OF ARTS, at 8.—The Mechanical Production of Cold: Prof. James A. Ewing, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electric Interlocking the Block and Mechanical Signals on Railways: Reply of F. T. Hollins to the Discussion.—Relative Size, Weight, and Price of Dynamo-electric Machines: E. Wilson.

SANITARY INSTITUTE, at 8.—Sanitary Laws and Regulations governing the Metropolis: A. Wynter Blyth.

CAMERA CLUB, at 8.15.—Silchester, the Result of Recent Explorations: H. Jones.

FRIDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 9.—Palestine Exploration: Lieut.-Colonel C. R. Conder.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Rockers and Expansion-Bearings as applied to Girders of Short Span: A. F. Baynham and F. B. H. Dobree.

SATURDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 3.—The Growth of the Mediterranean Route to the East: W. Frewen Lord.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—On Human Nature: A. Schopenhauer, selected and translated by T. B. Saunders (Sonnenschein).—Elements of Theoretical Physics: Dr. C. Christiansen, translated by Prof. W. F. Magie (Macmillan).—Zeit-und Streitfragen der Biologie: Dr. O. Hertwig, Heft 2 (Jena, Fischer).—Beiträge zur Kenntnis der Septalnectarien: J. Schniewind-Thies (Jena, Fischer. Beiträge zur Lehre von der Fortpflanzung der Gewächse: Dr. M. Möbius (Jena, Fischer)—Kainogenesis als Ausdruck differenter Phylogenetischer Energien: Dr. E. Mehnert (Jena, Fischer).—Das Botanische Practicum: Dr. E. Strasburger, Dritte Umgearbeitete Auflage (Jena, Fischer)—Wasted Records of Disease: C. E. Paget (Arnold).—Farthest North: Dr. F. Nansen, 2 Vols. (Constable).—Physics, an Elementary Text-Book for University Classes: Dr. C. G. Knott (Chambers).—Handbook for Mechanical Engineers: Prof. H. Adams, 4th edition (Spon).—Recueil de Procédés de Dosage: Prof. G. Arth (Paris, Carré).—Massachusetts Institute of Technology, Boston, Annual Catalogue, 1896–97 (Cambridge, Mass.).—Report of the Commissioner of Education for the Year 1894–5, 2 Vols. (Washington).

PAMPHLETS.—Photography as a Hobby: M. Surface (Lund).—Geological Literature added to the Geological Society's Library during the Year ended December 31, 1896 (Geological Society).—Tabellen für Gasanlysen, &c.: Prof. G. Lunge (Braunschweig, Vieweg).

SERIALS.—Engineering Magazine, February (Tucker).—Quarterly Journal of the Geological Society, Vol. liii. Part 1. No. 209 (Longmans).—General Index to the First Fifty Volumes of the Quarterly Journal of the Geological Society, Part 1 (Longmans).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1896, No. 12 (Bruxelles).—Minnesota Botanical Studies, Bulletin No. 9 (Minneapolis).—Journal of the Franklin Institute, February (Philadelphia).—American Naturalist, February (Philadelphia).

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